



TASK CONCURRENCY MANAGEMENT DESIGN METHOD

Catthoor et al.

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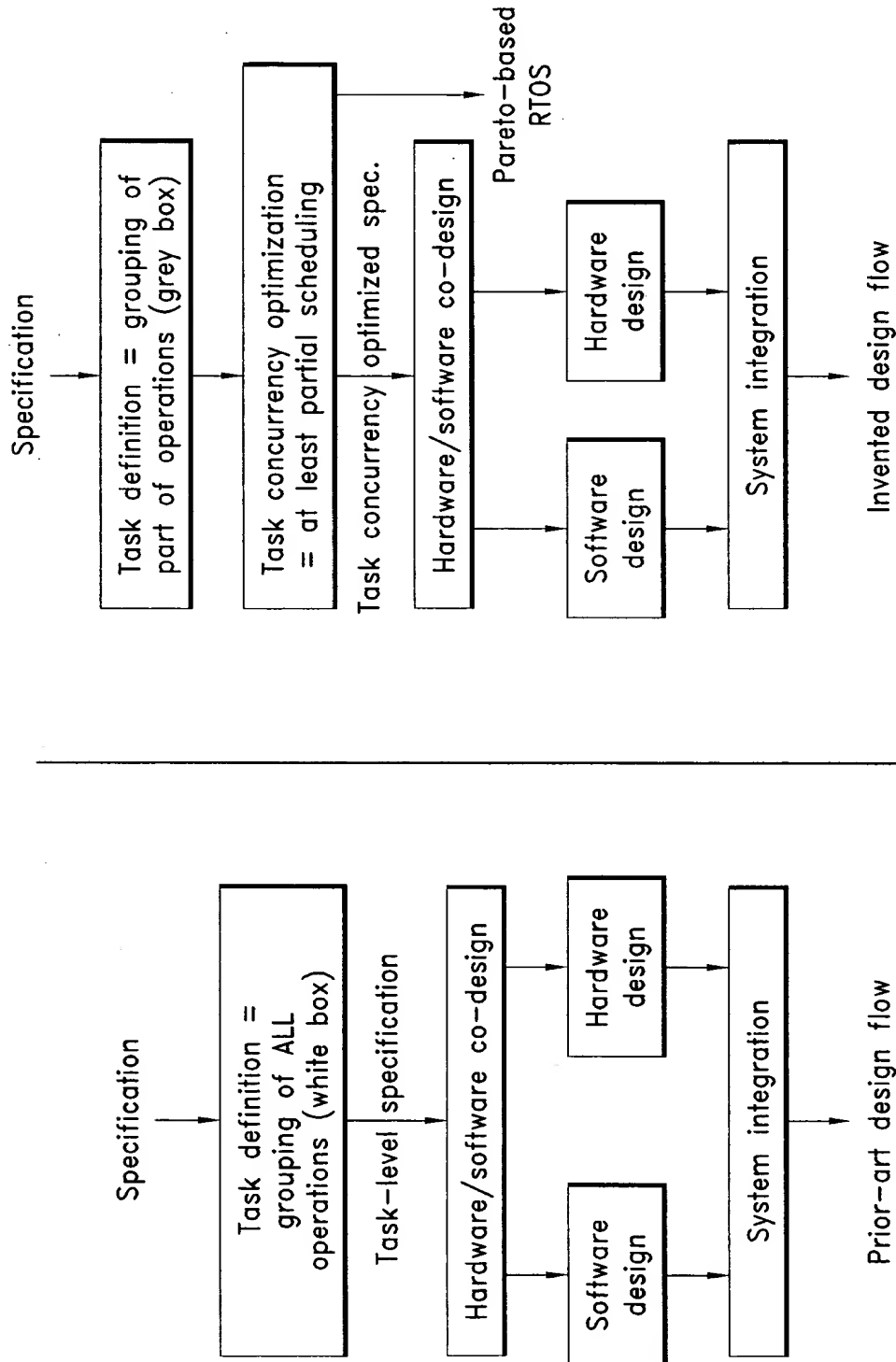


FIG. 1  
(PRIOR ART)

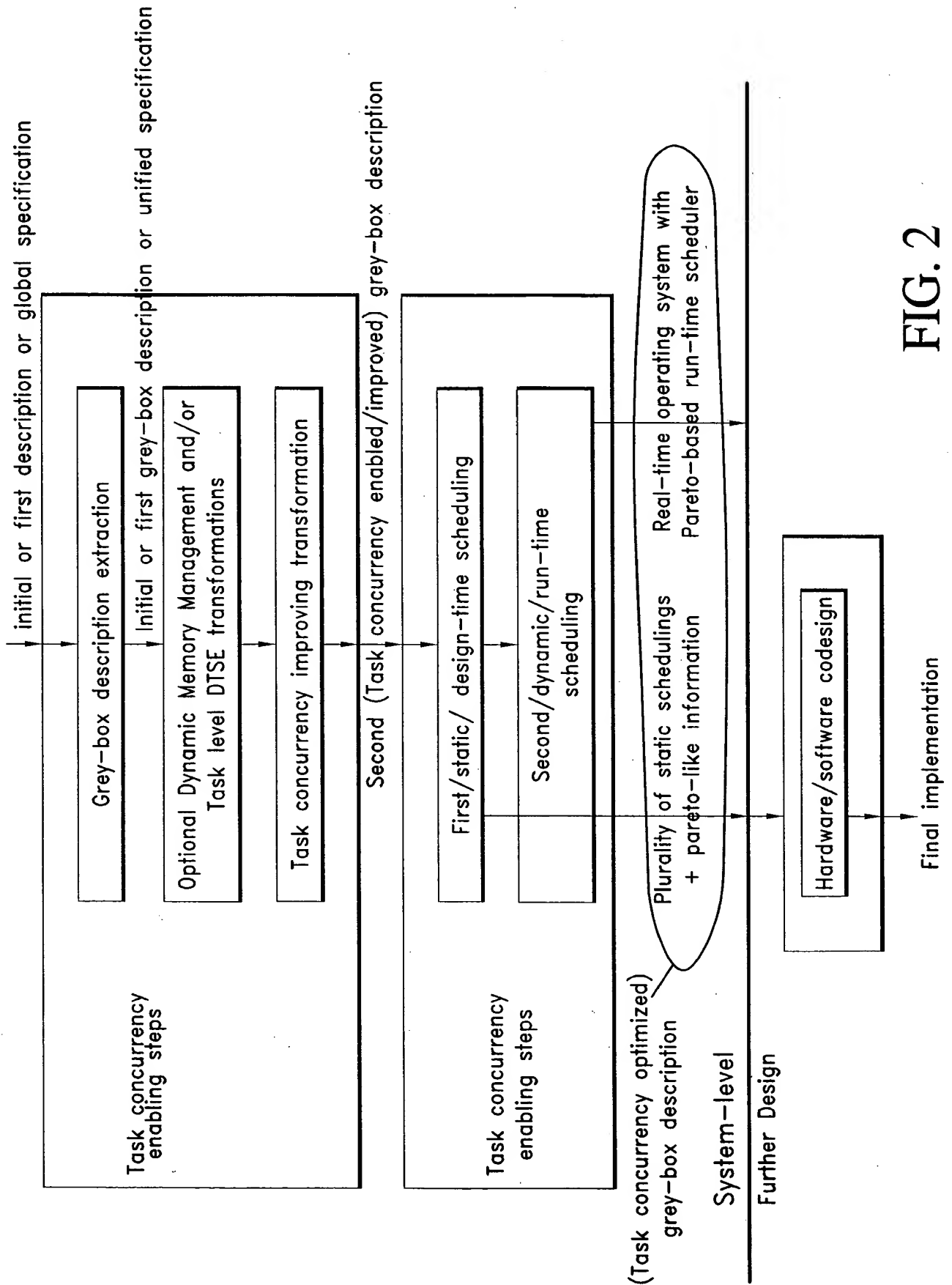


FIG. 2

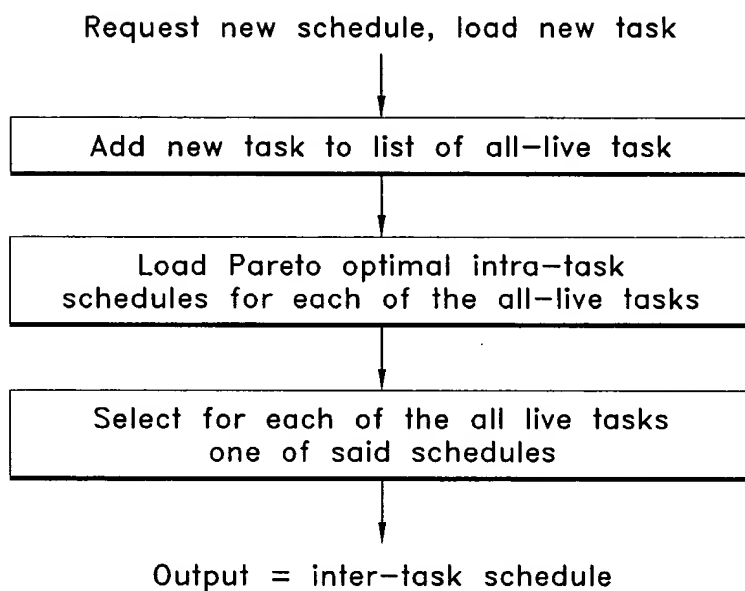


FIG. 3

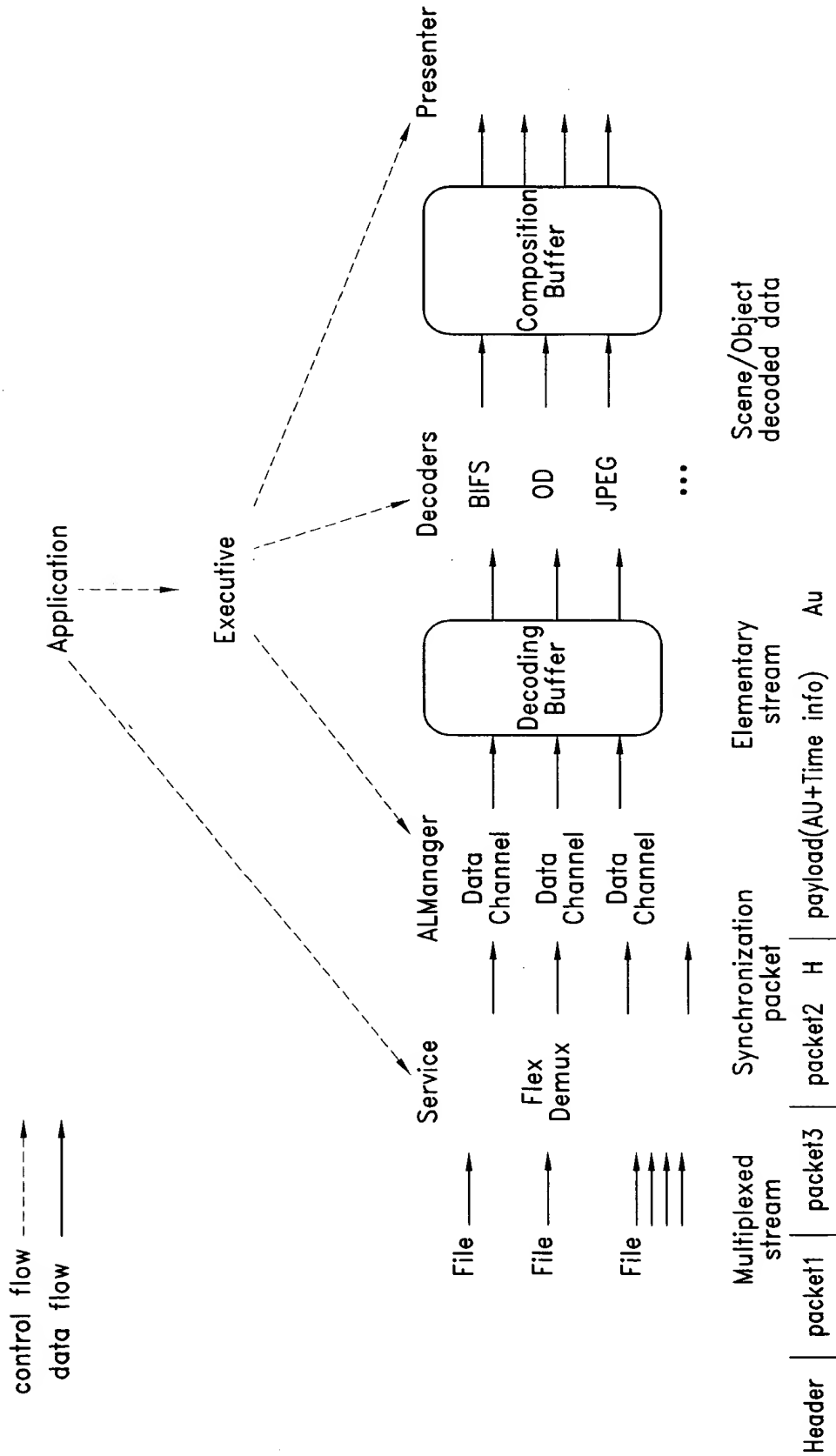


FIG. 4

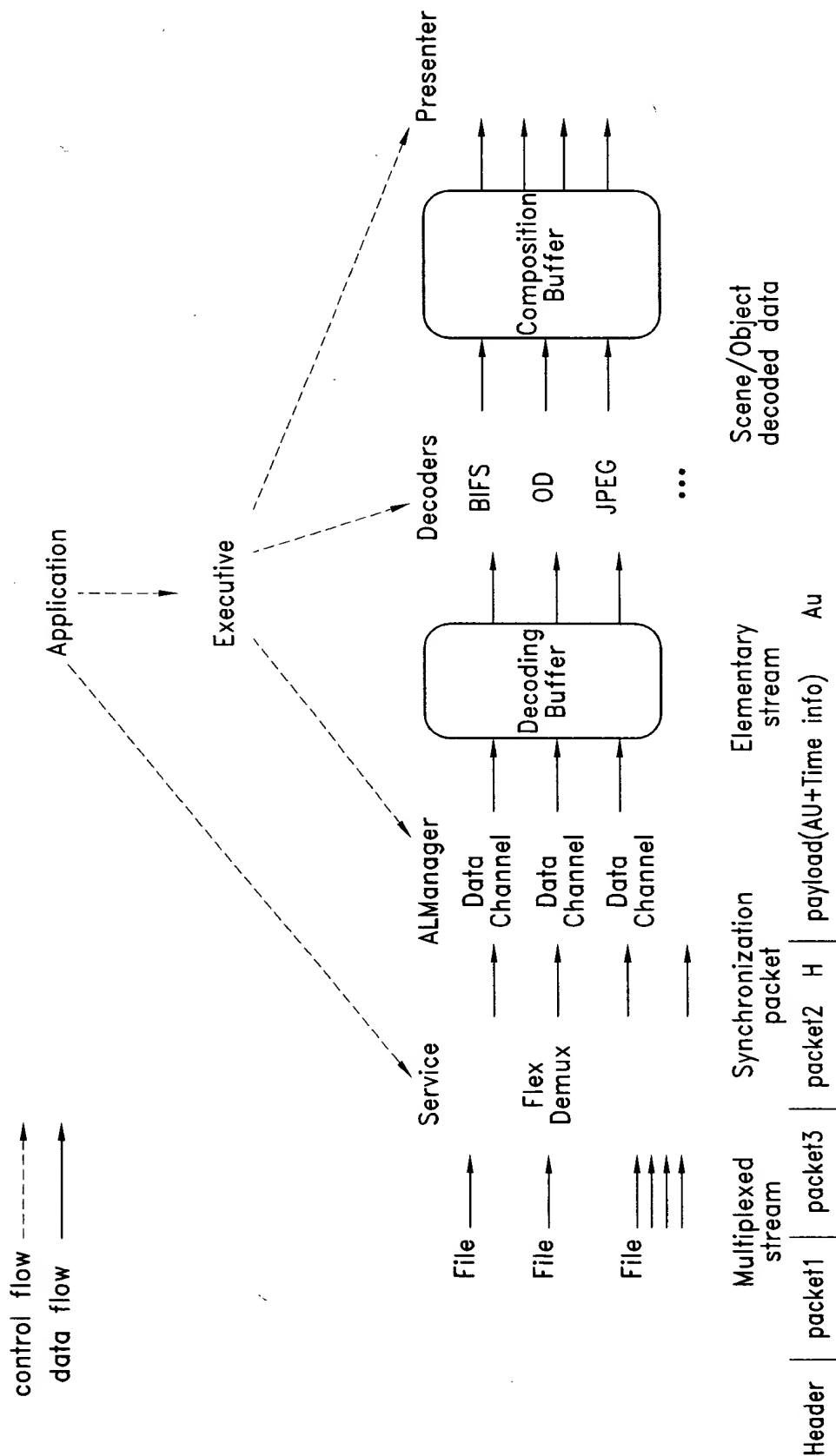


FIG. 5



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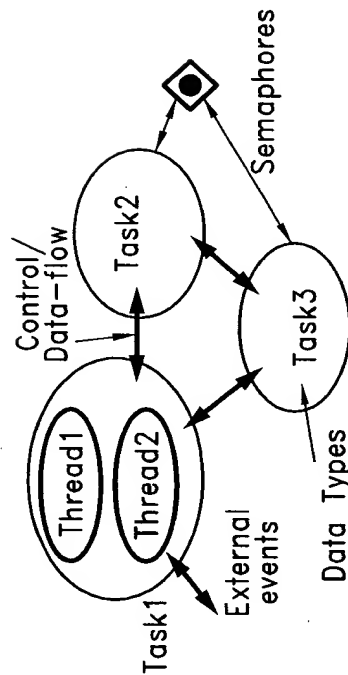


FIG. 6



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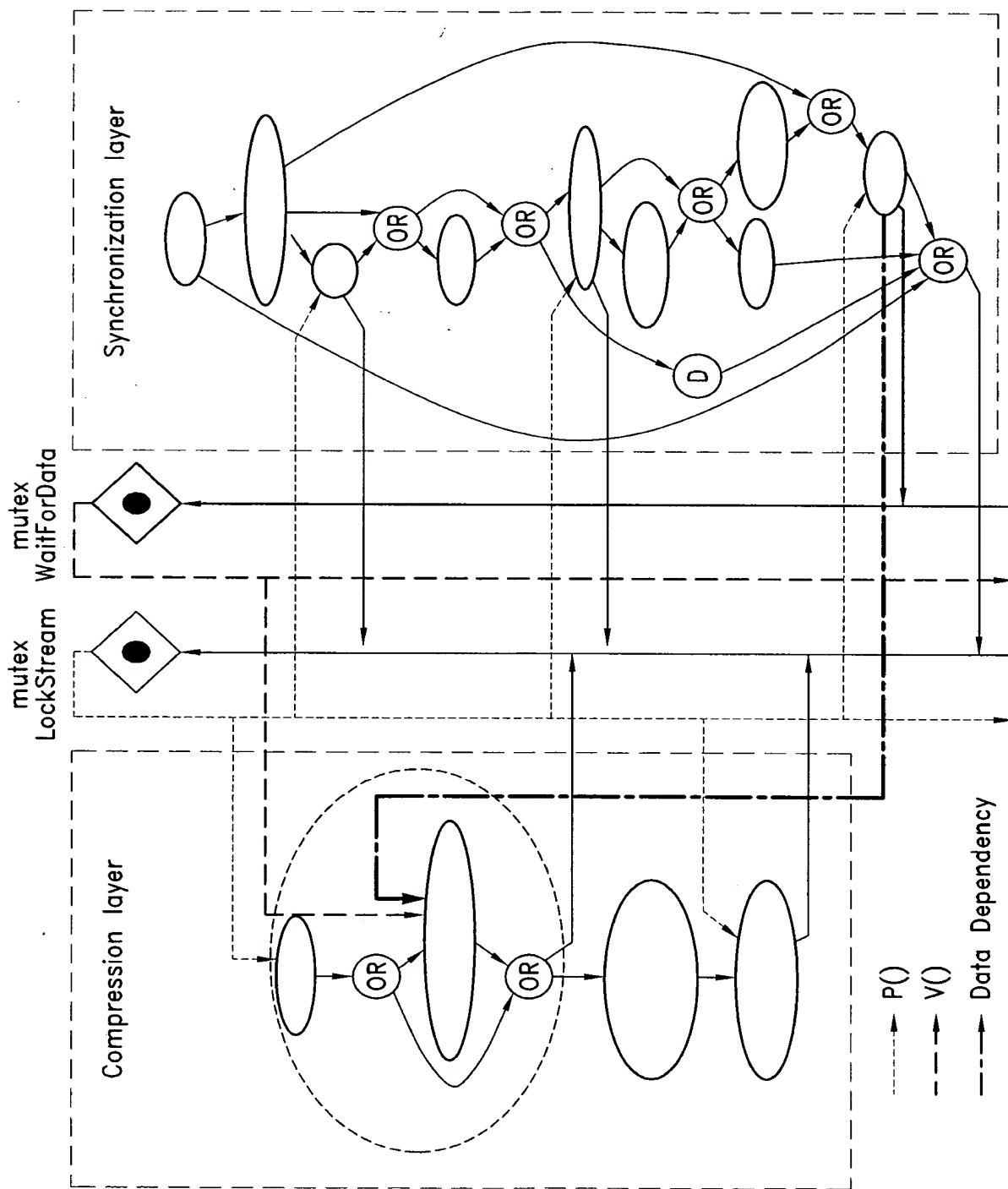


FIG. 7



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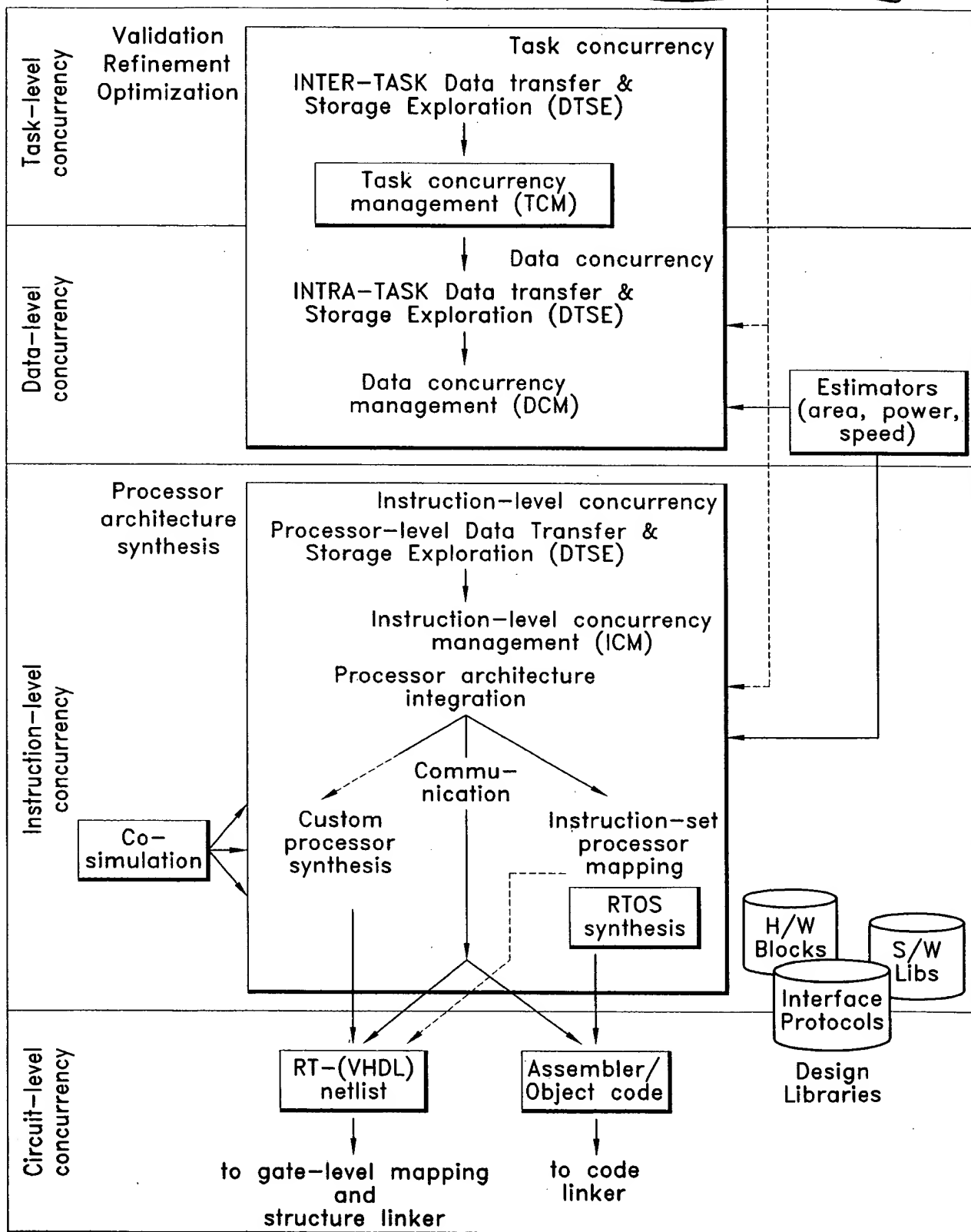
Design  
Co-SpecificationConstraints  
(area, power, timing)

FIG. 8



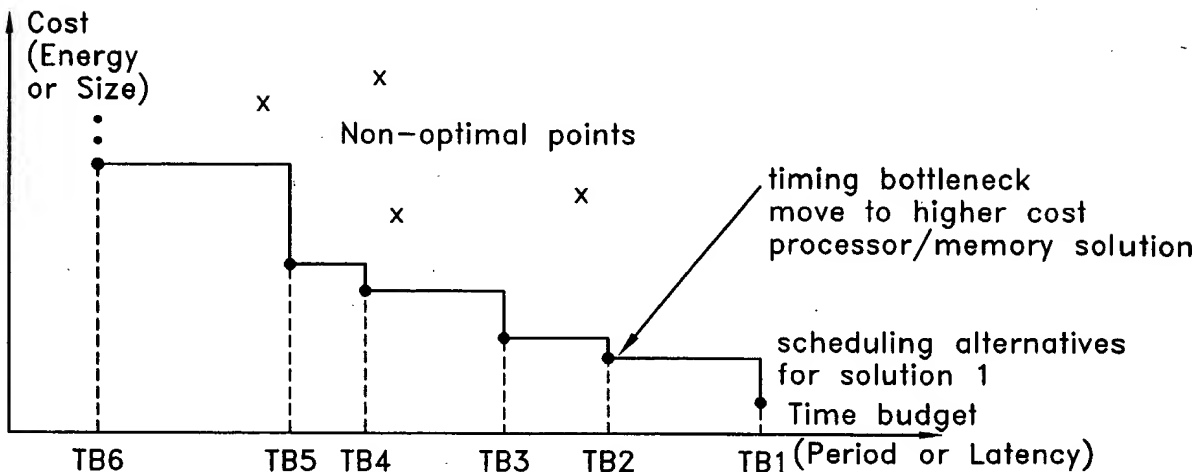


FIG. 9

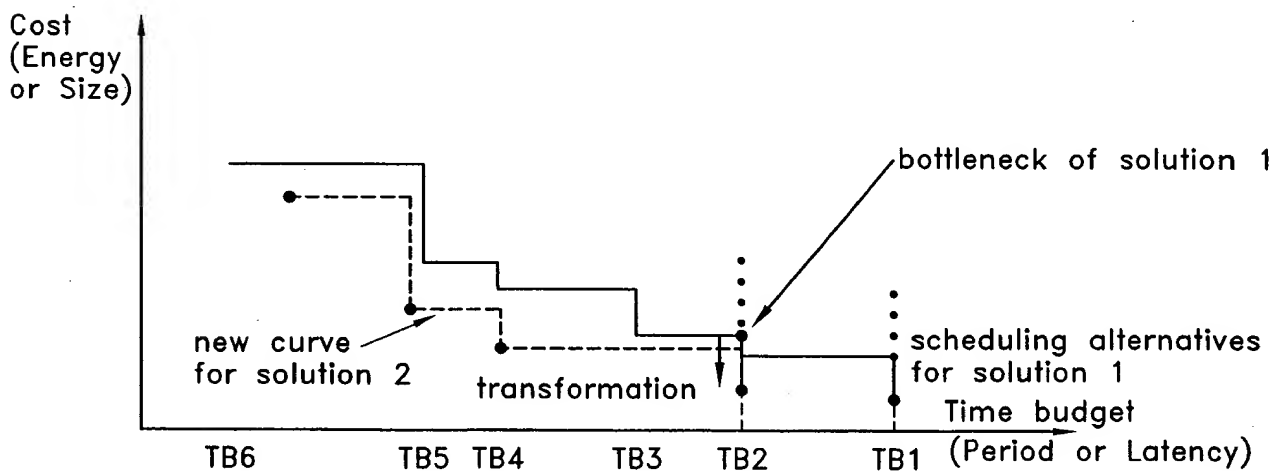


FIG. 10

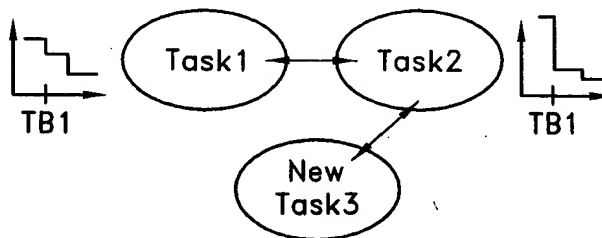


FIG. 11

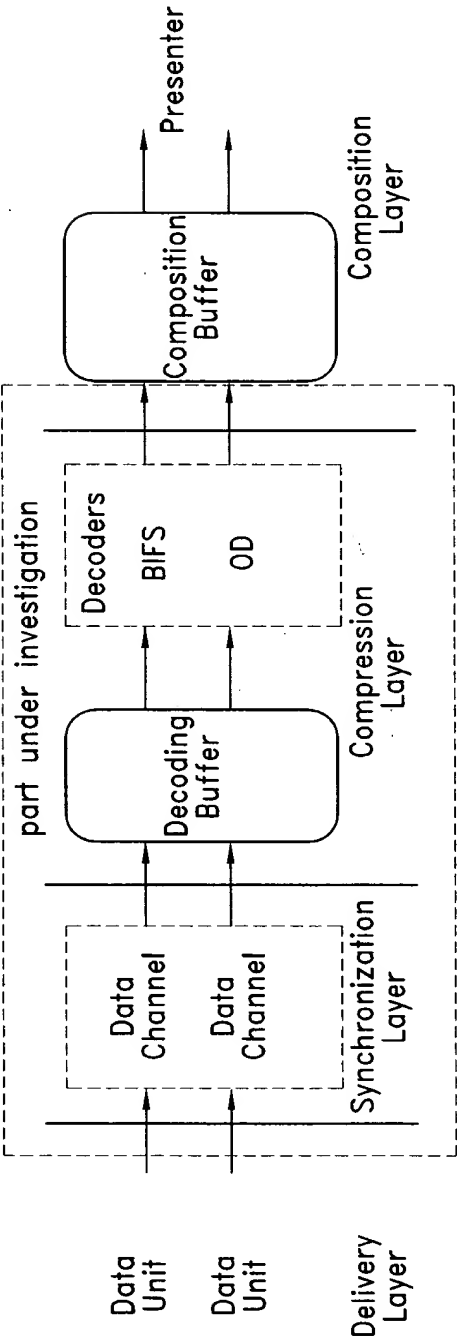


FIG. 12

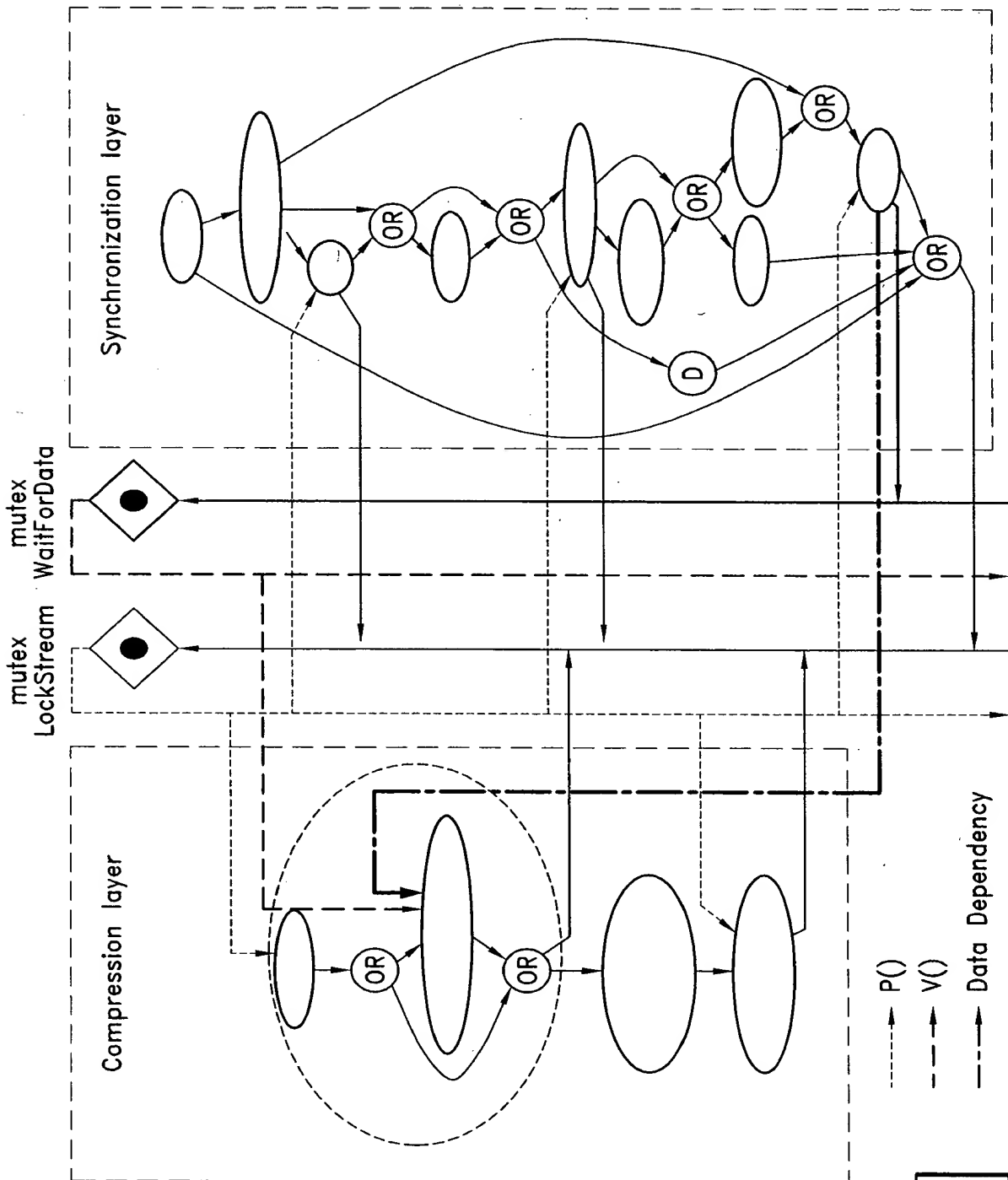


FIG. 13<sub>A</sub>

FIG. 13<sub>A</sub> FIG. 13<sub>B</sub>

FIG. 13

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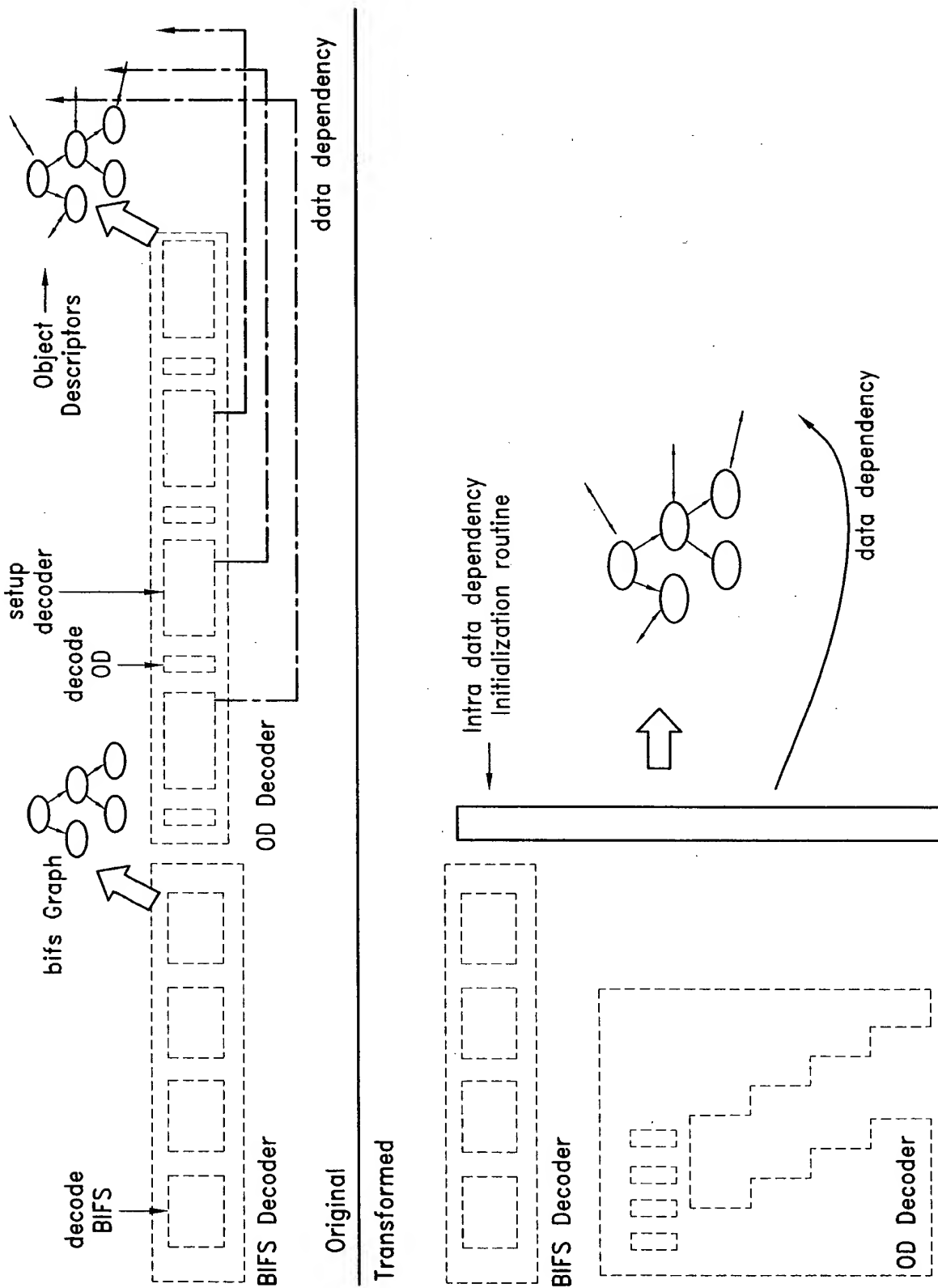


FIG. 13<sub>B</sub>



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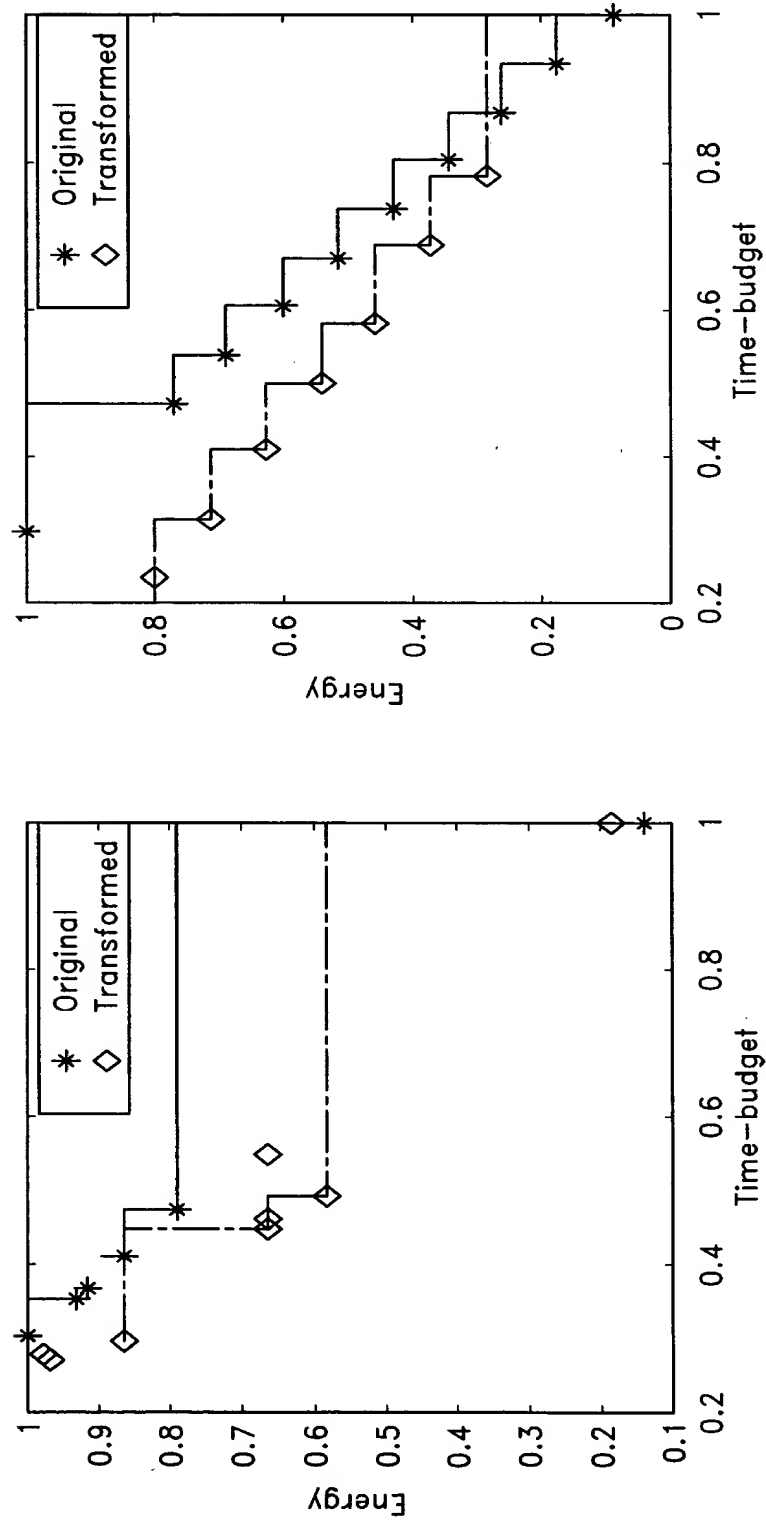


FIG. 14





Example in IM1

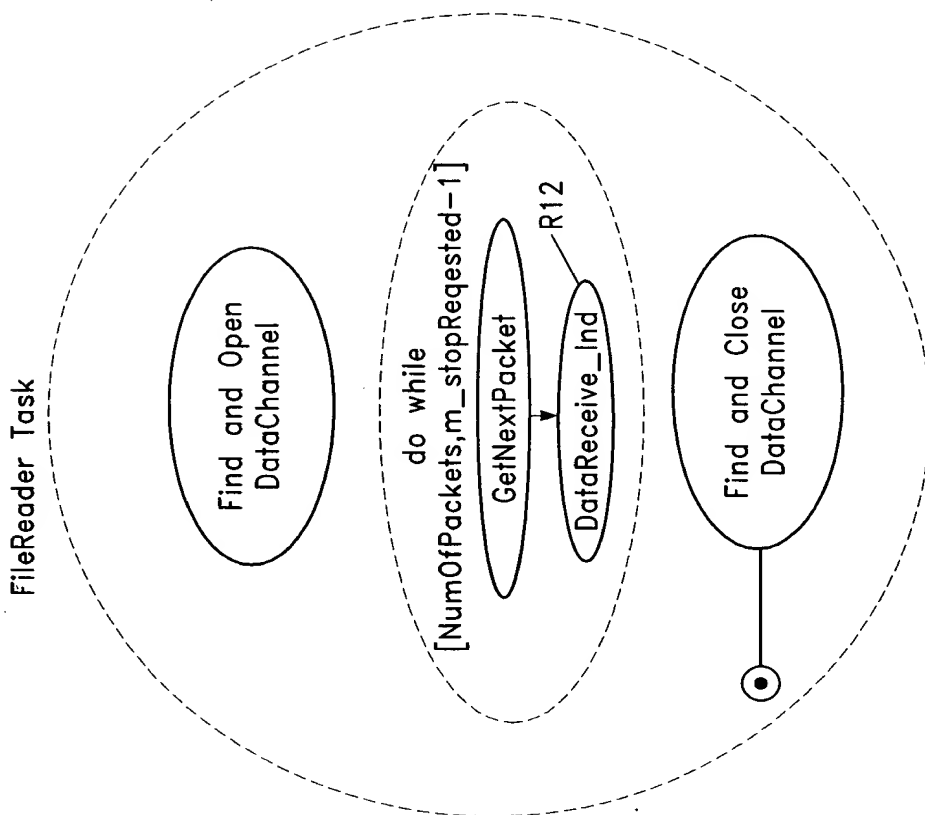


FIG. 16

Hide undesired constructs without trade-off to simplify the graph

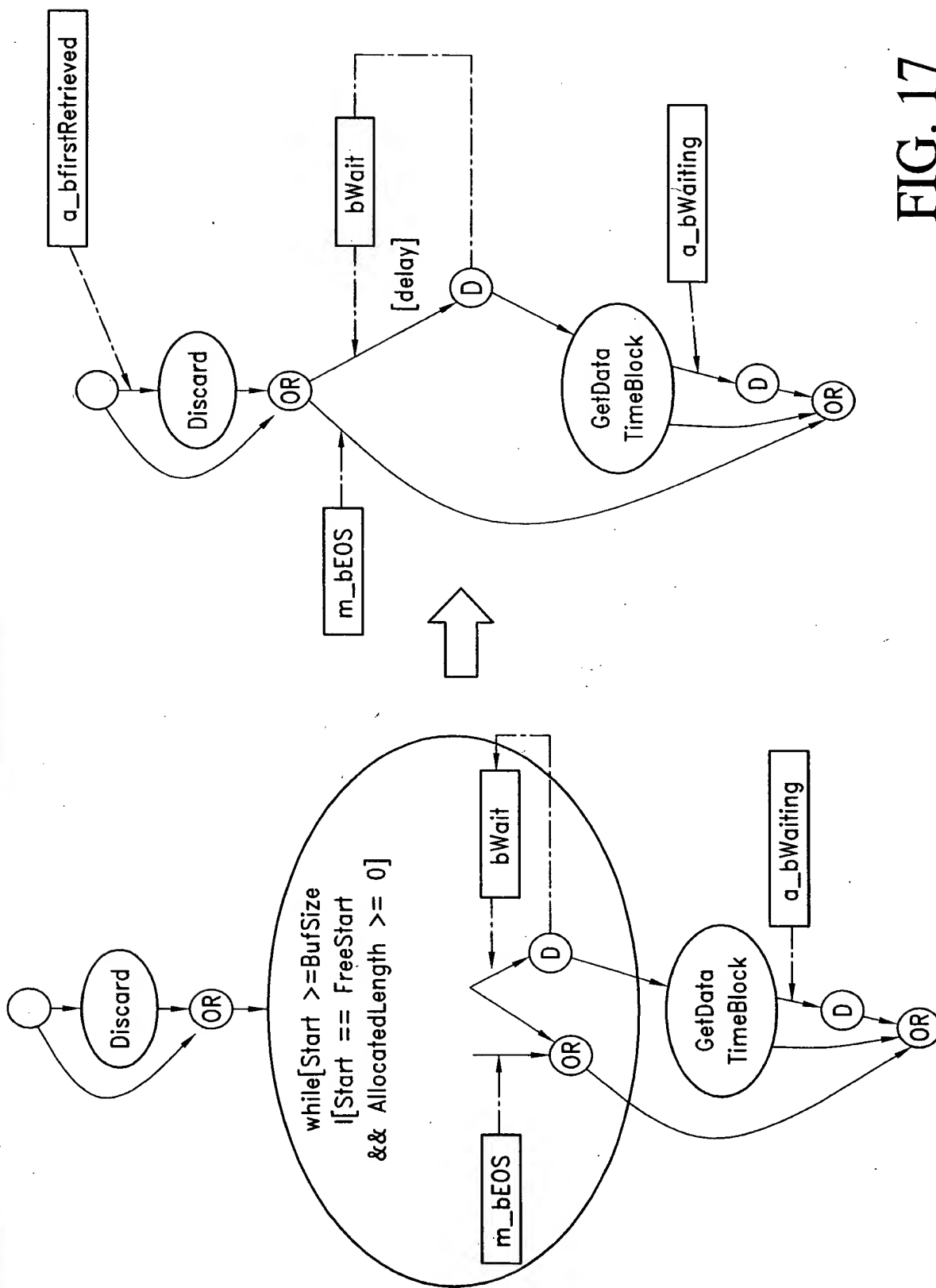


FIG. 17





Code expansion creates freedom for scheduling

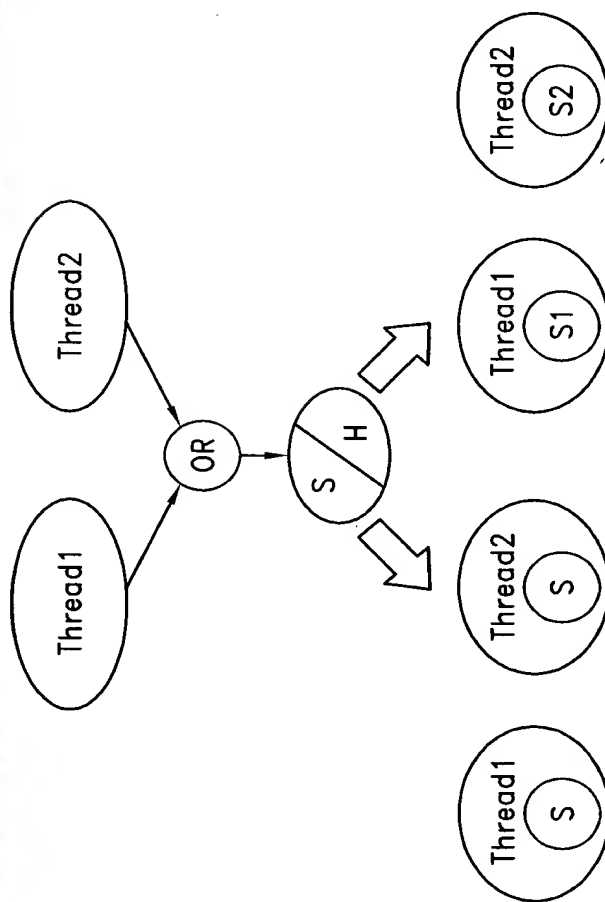


FIG. 18

Code expansion in IM1(1)

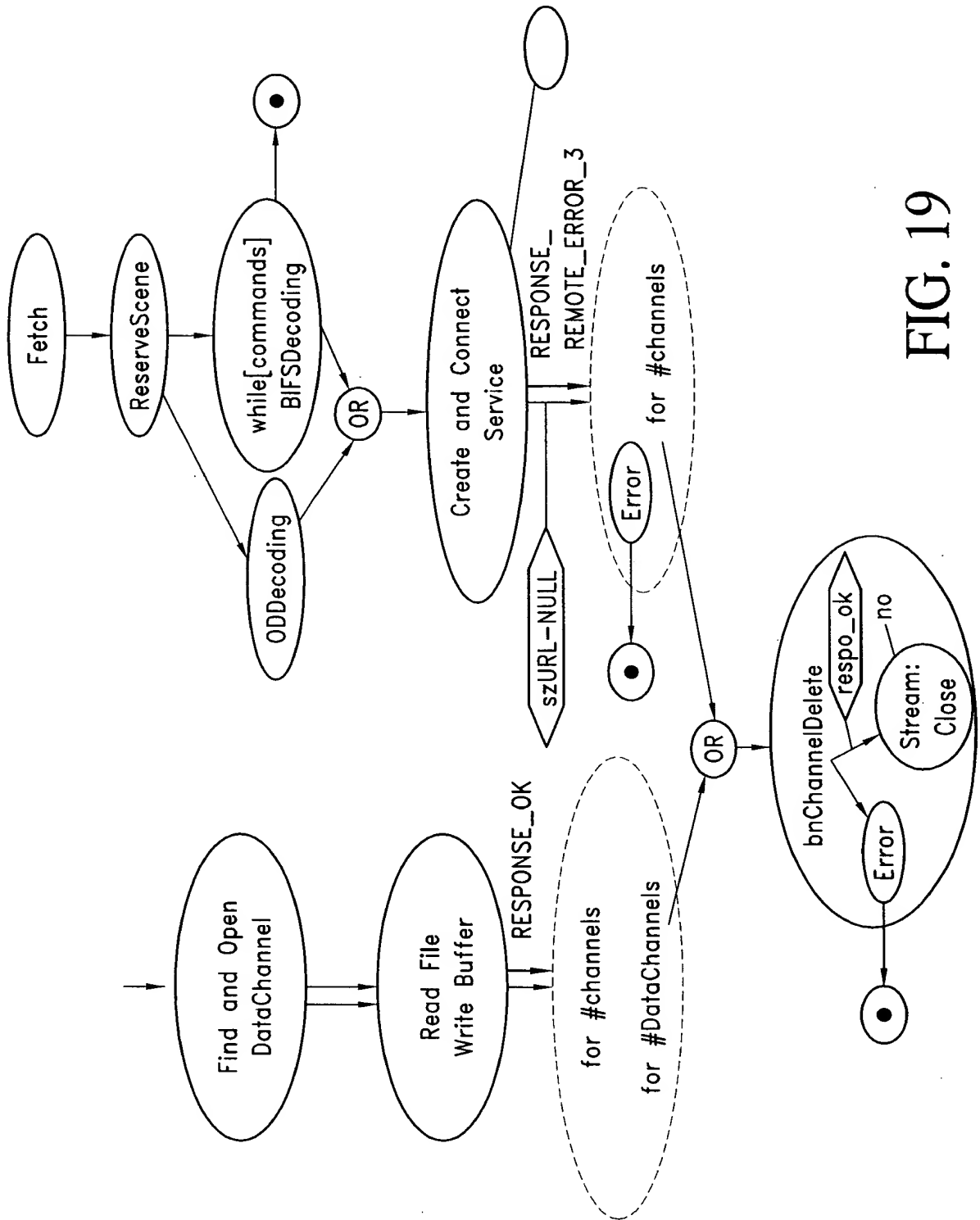
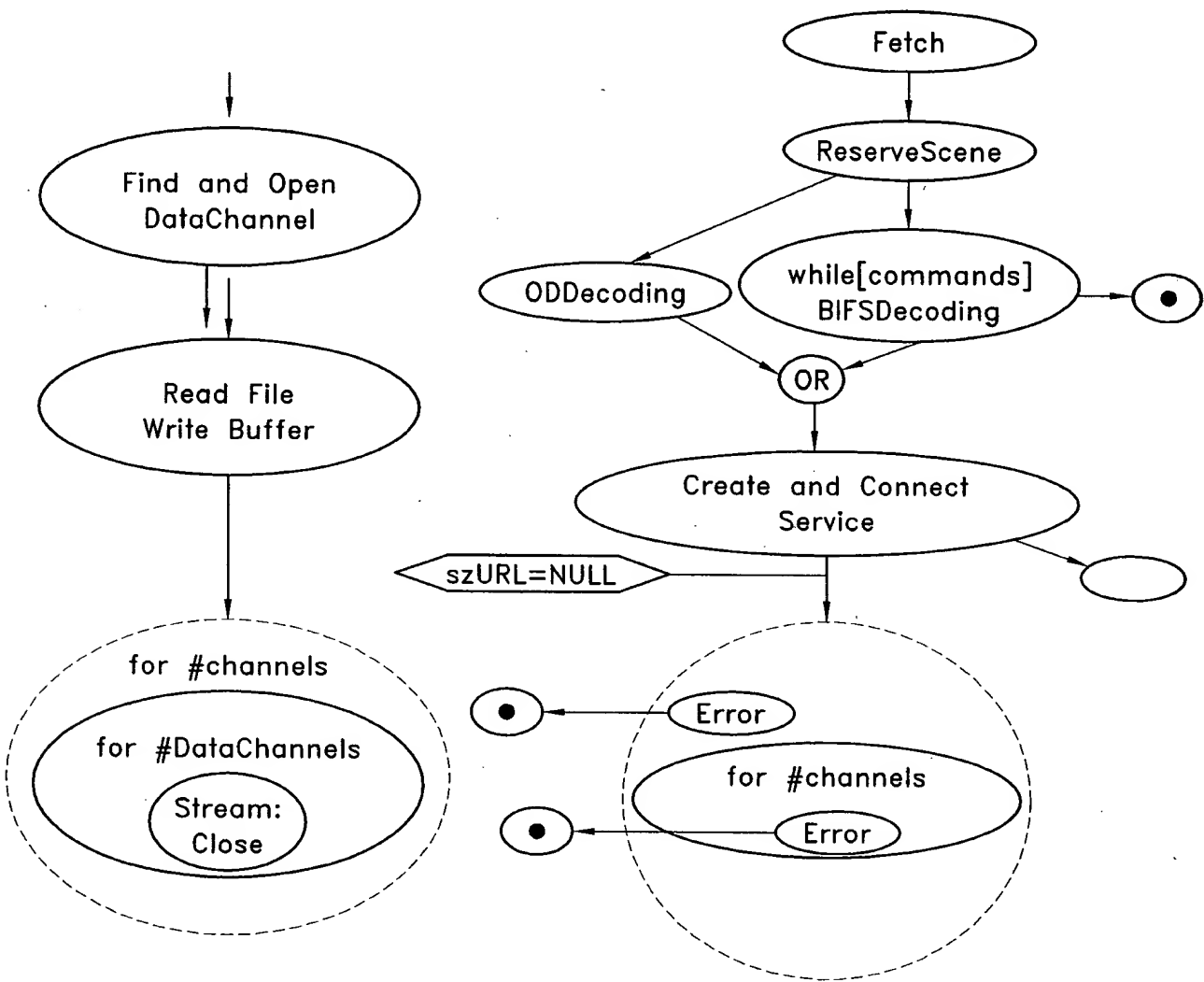


FIG. 19

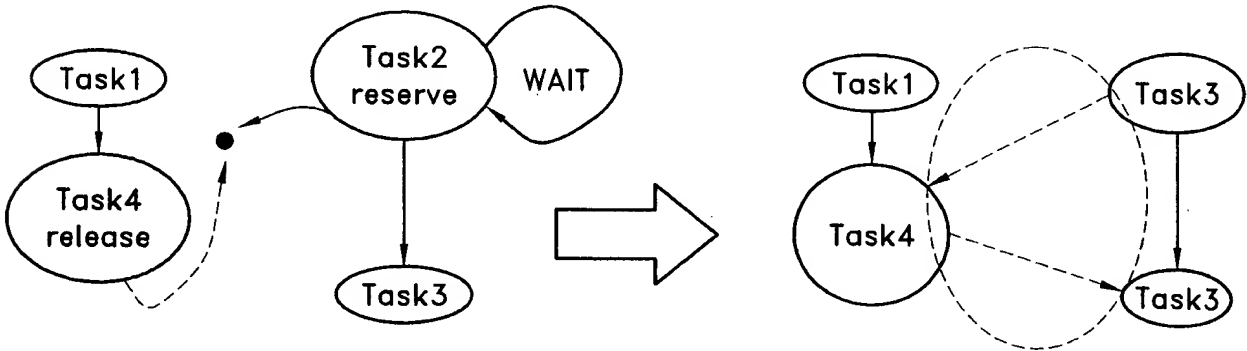
Code expansion in IM1(2)

FIG. 20



Remove constructs that make concurrency analysis difficult

FIG. 21





Trade-off complexity/freedom must be taken into account (2)

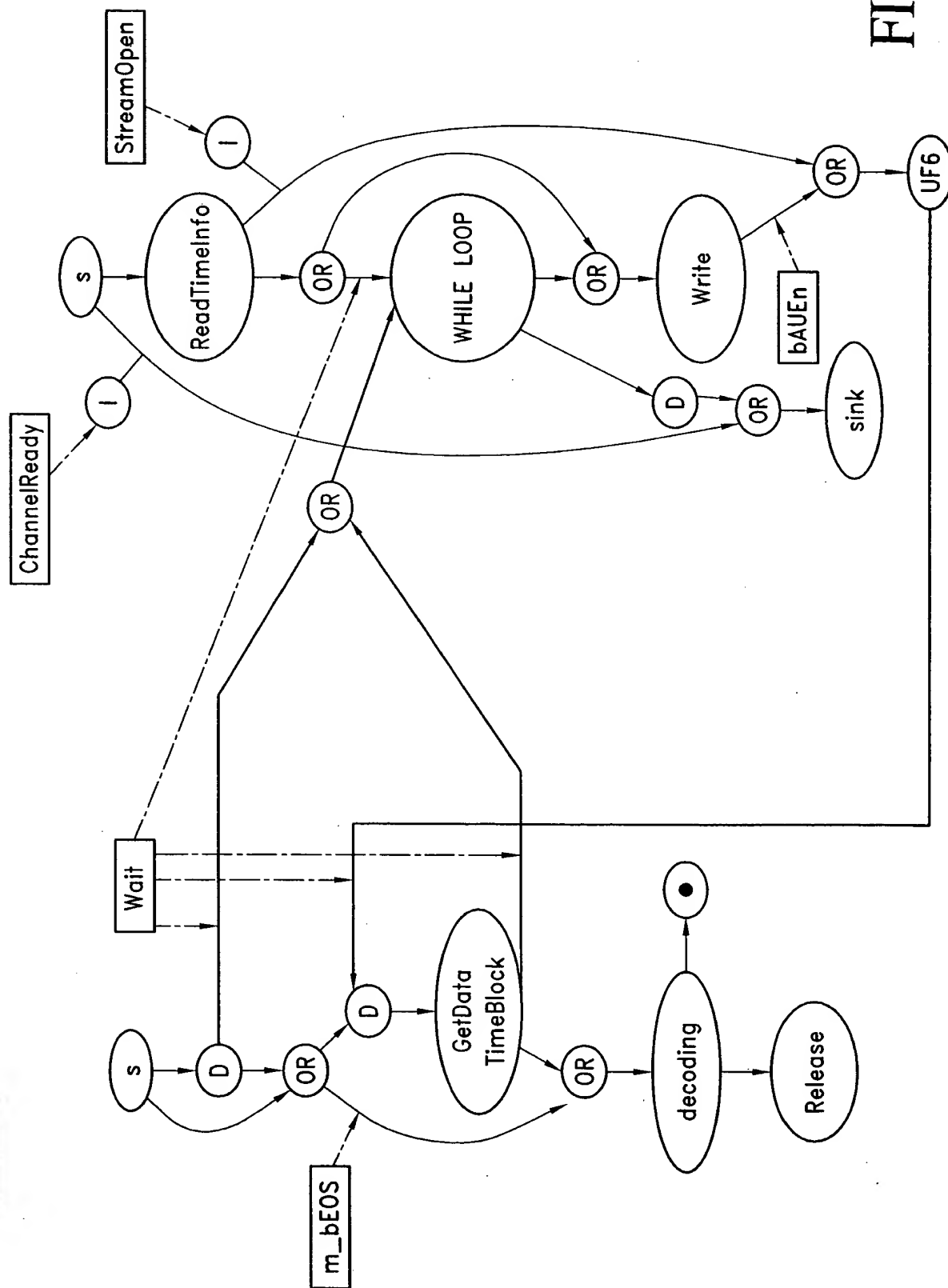


FIG. 23

Transform constructs that cannot be removed

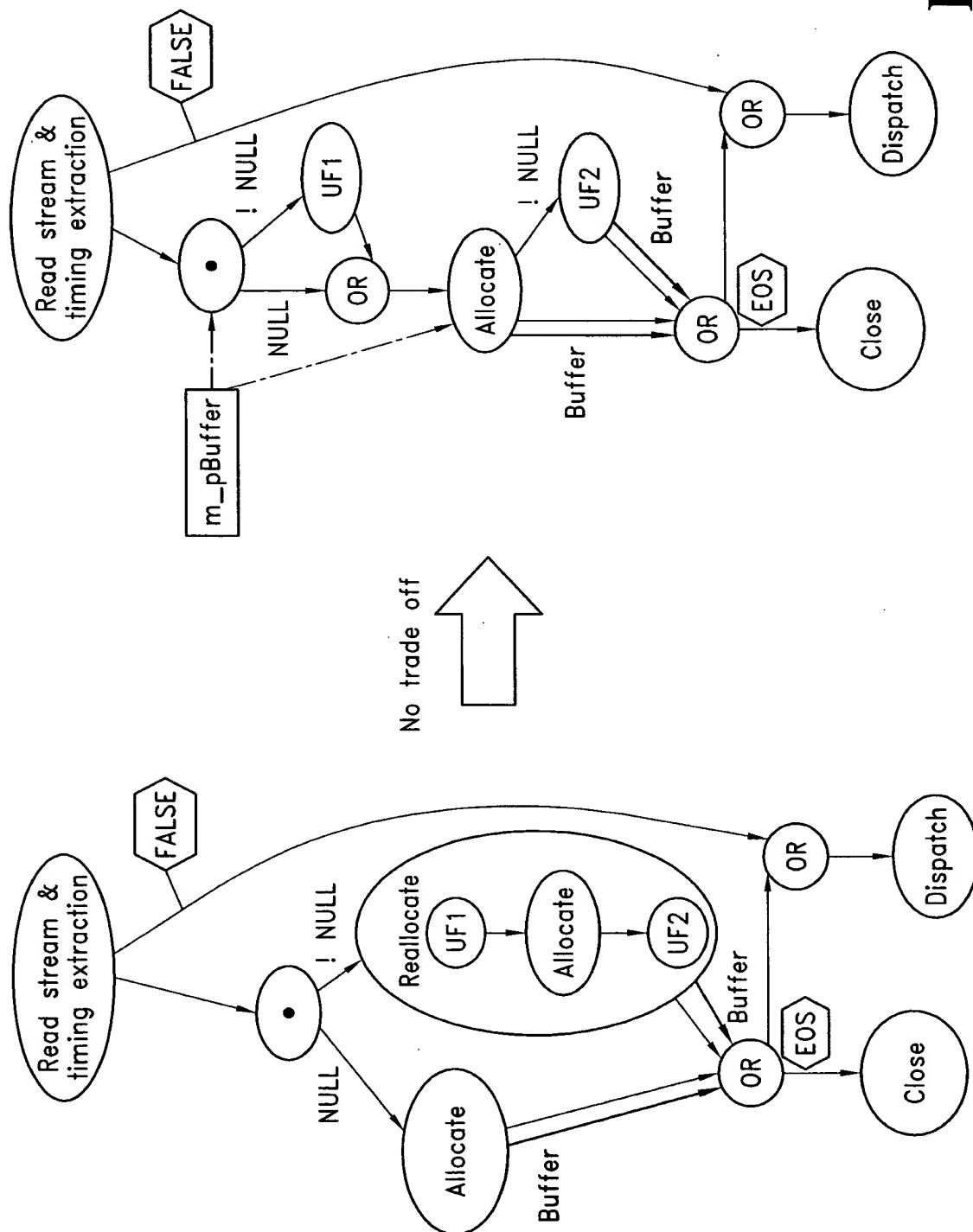


FIG. 24

Concurrency analysis focuses on the parallelism

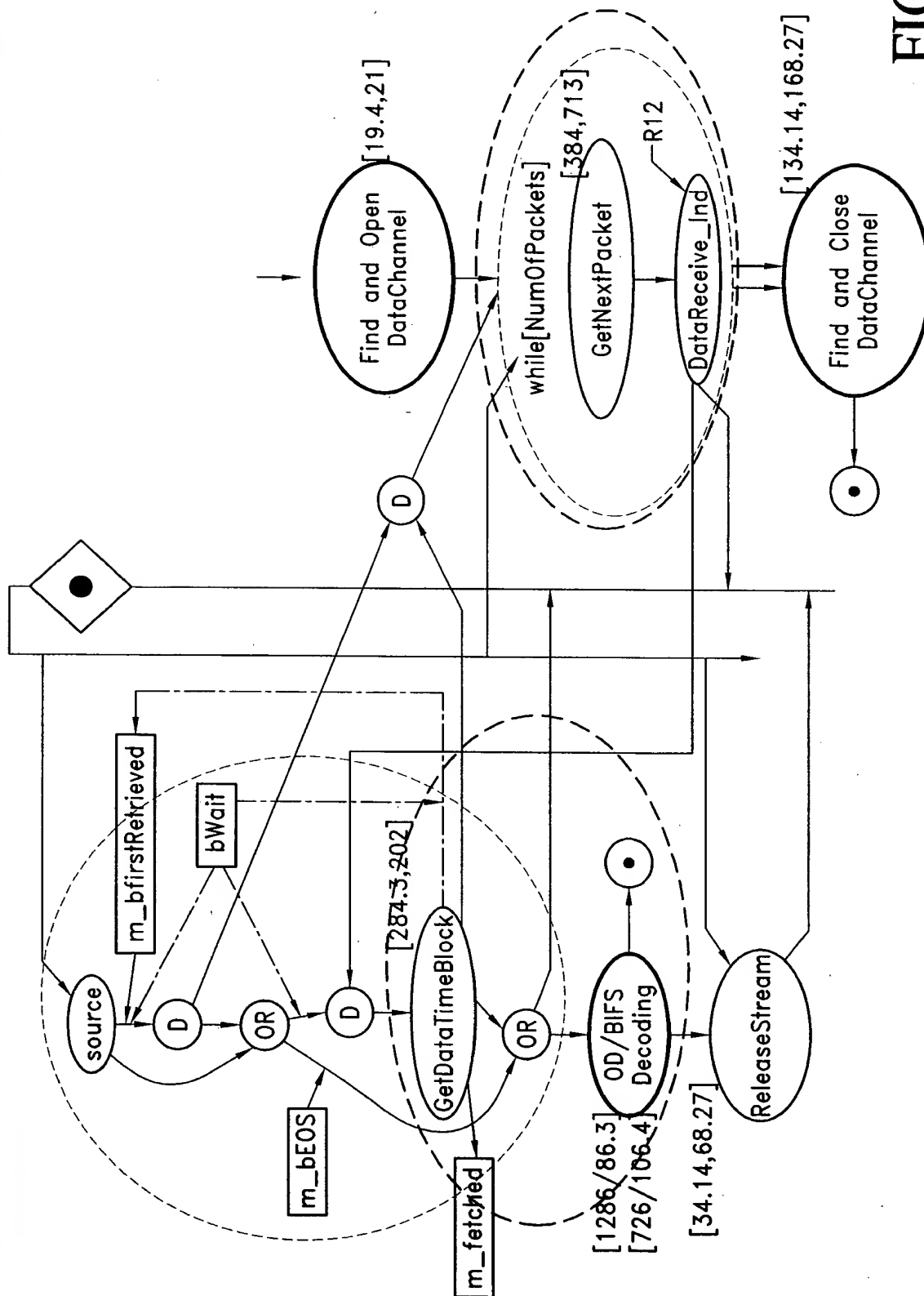


FIG. 25

Remove unused or redundant code

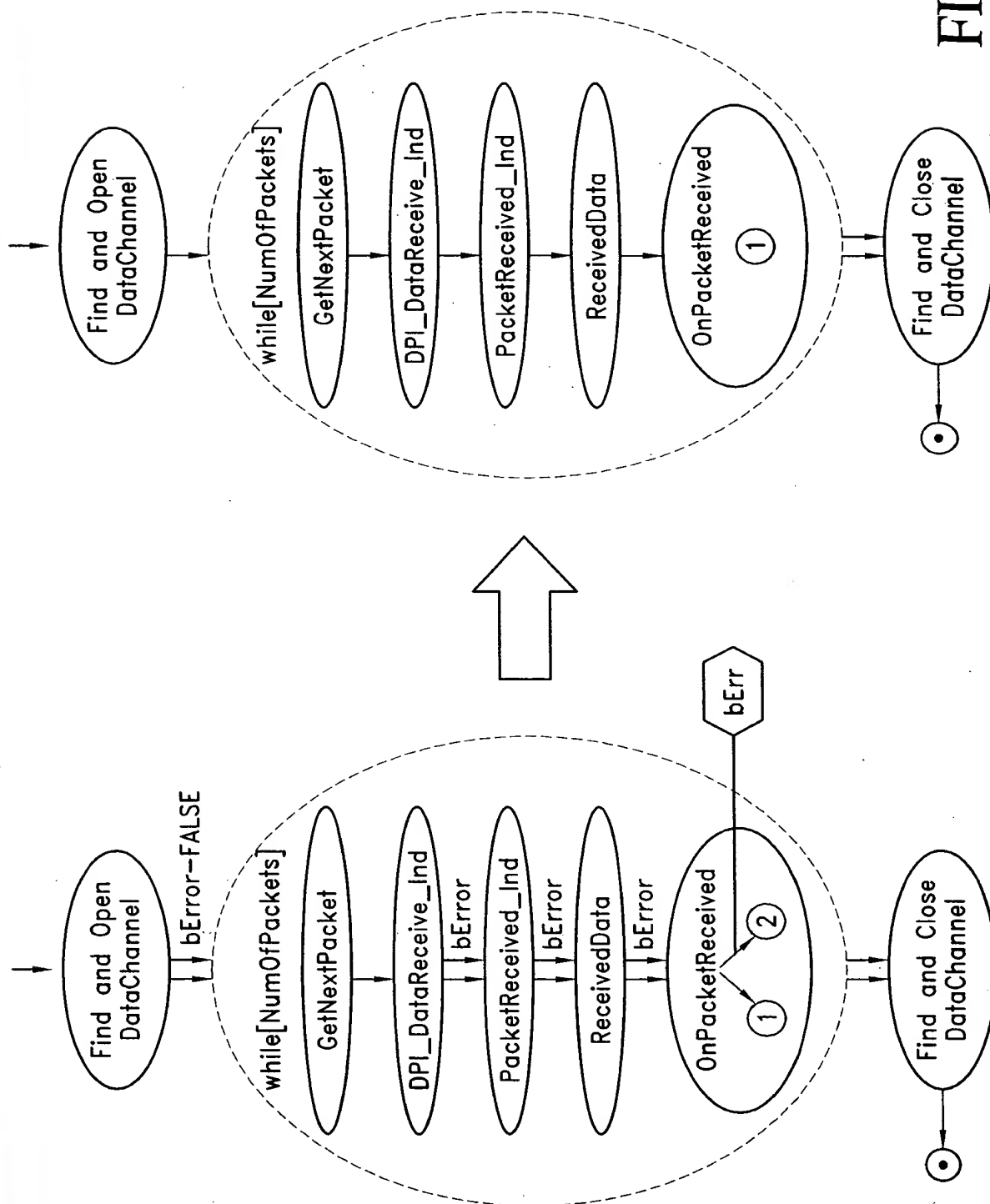


FIG. 26



Weight-based hiding reduces complexity further with trade-off

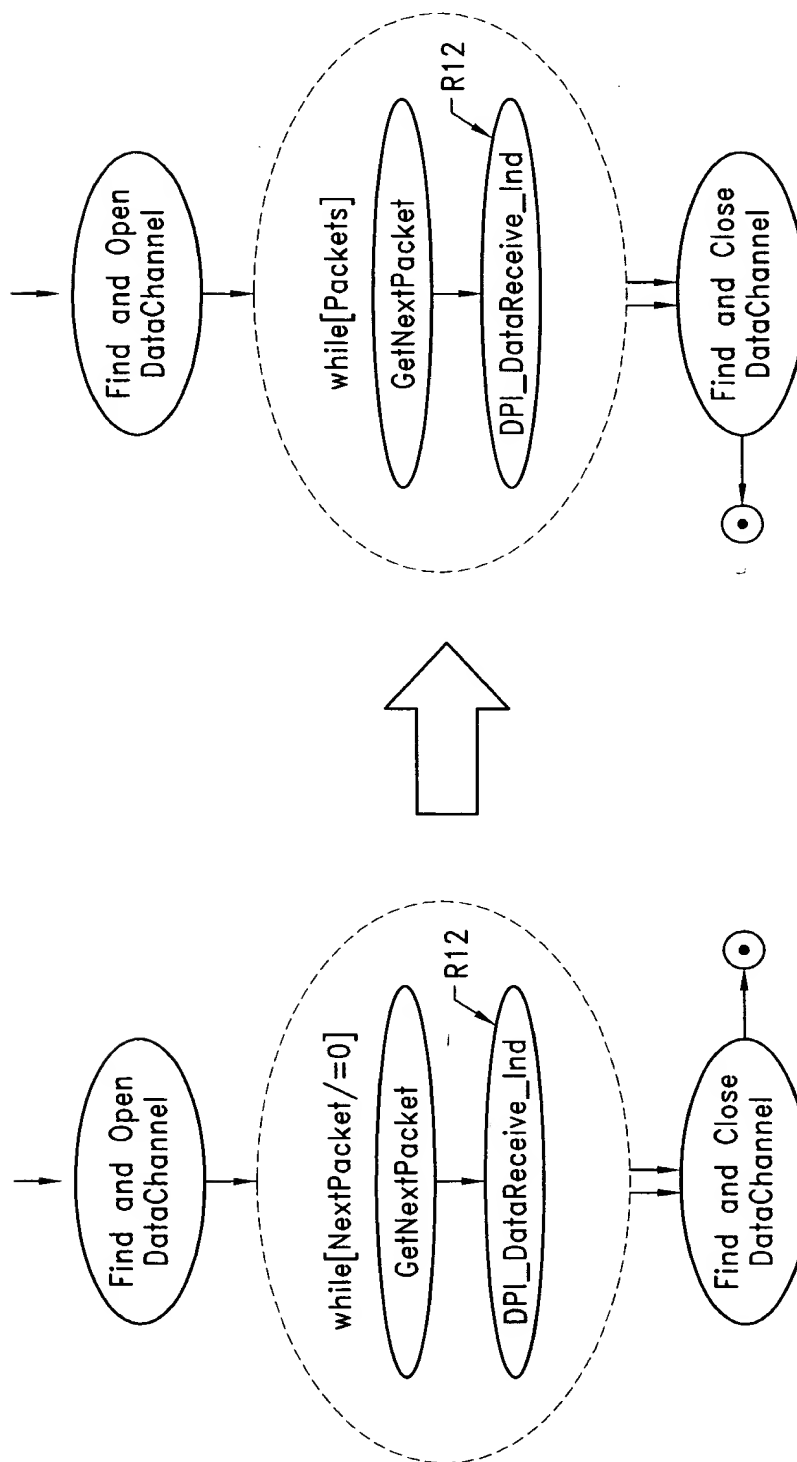


FIG. 27

Partitioning clusters tasks with high interaction

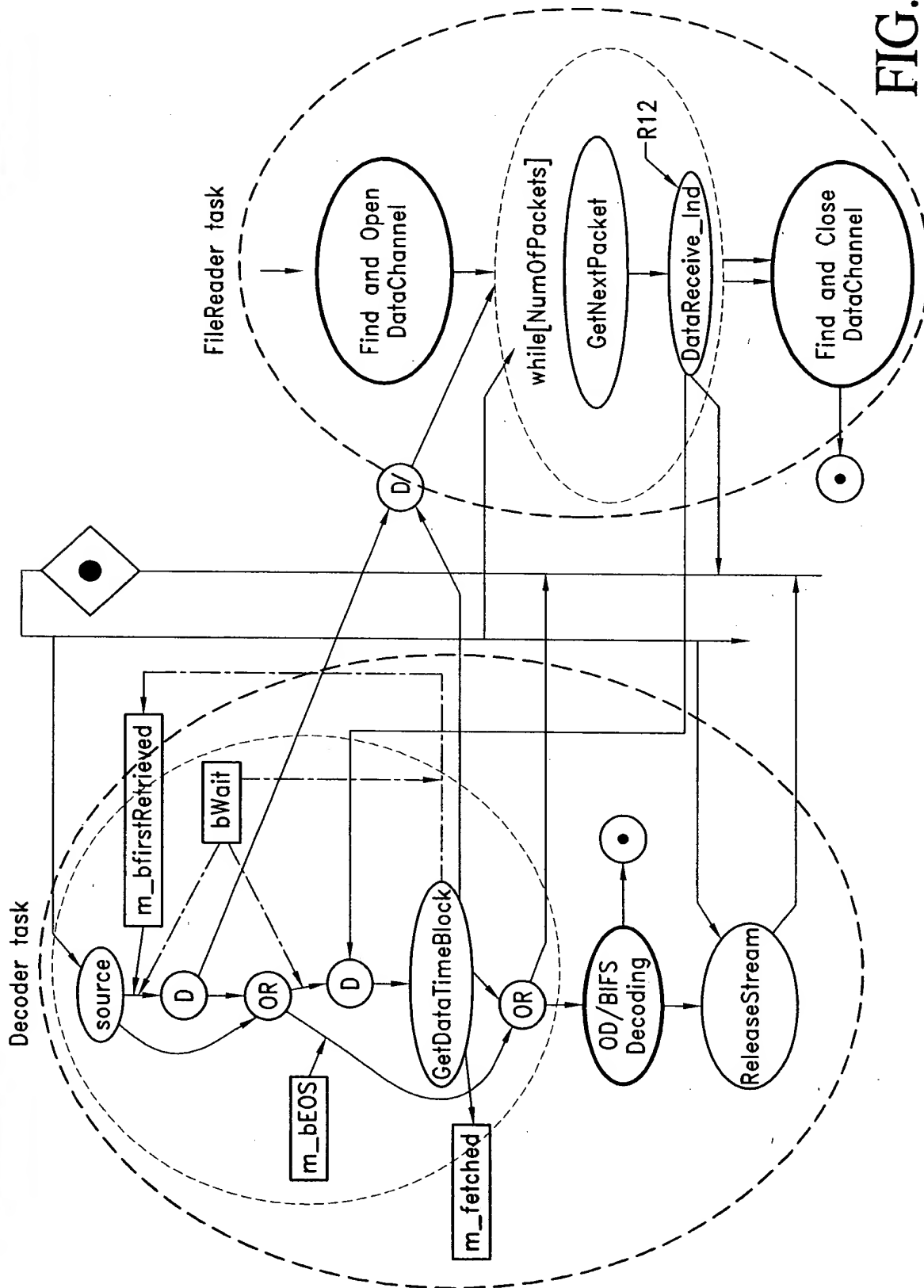


FIG. 28



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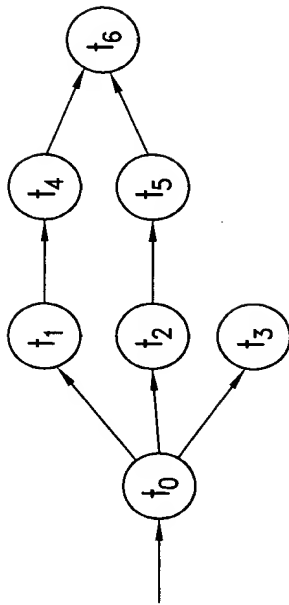


FIG. 29

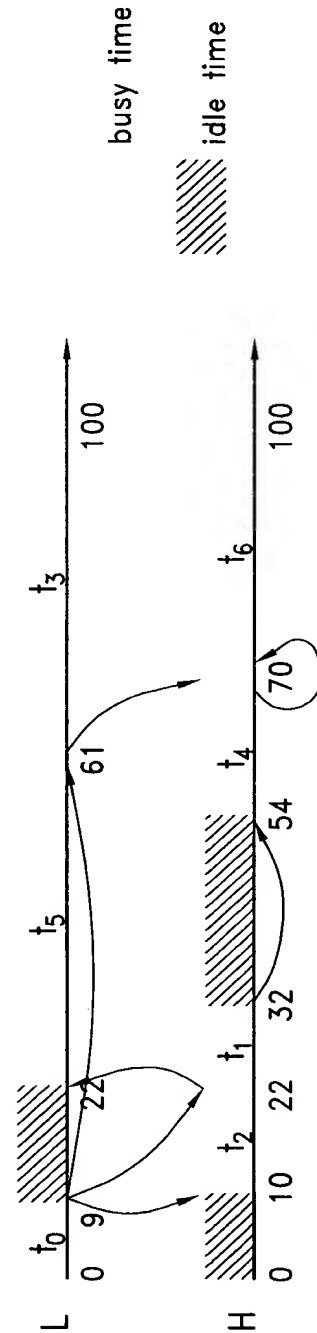


FIG. 30



FIG. 31

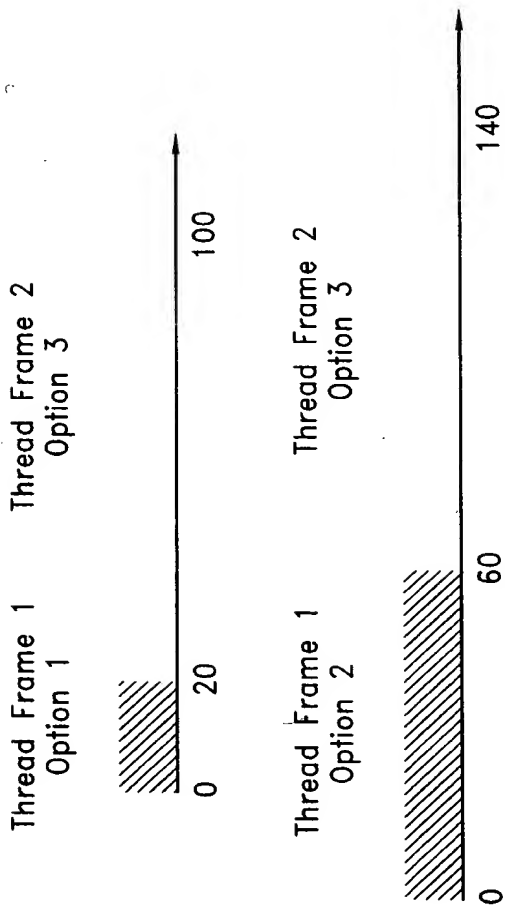
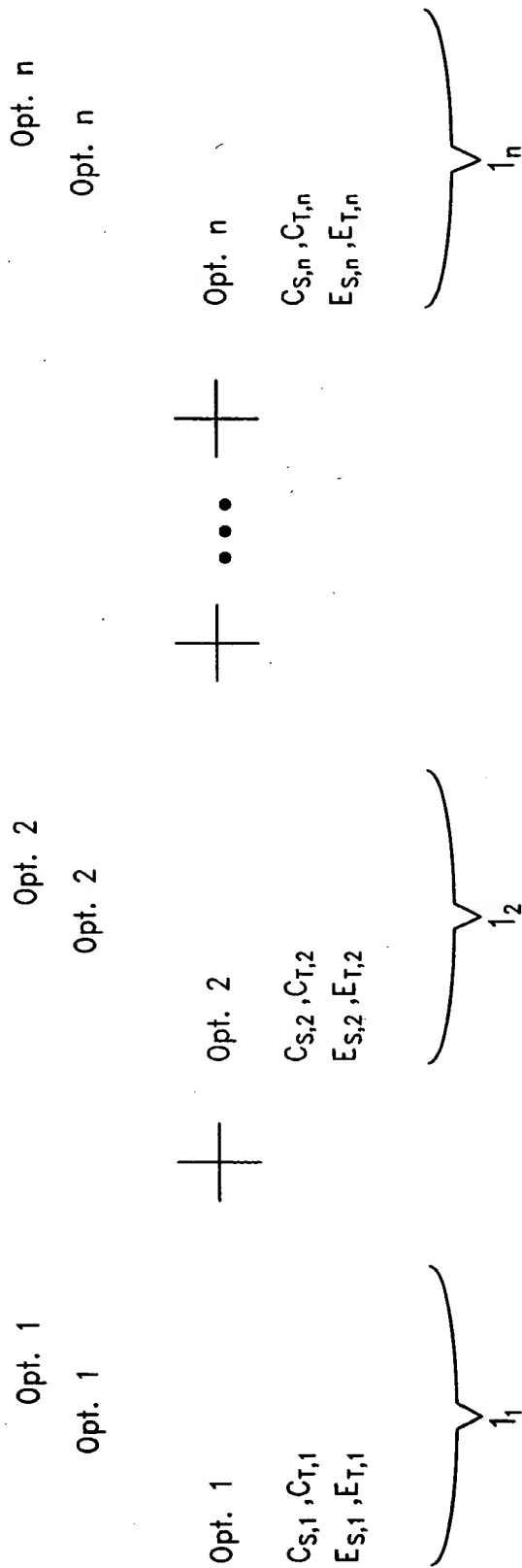


FIG. 32



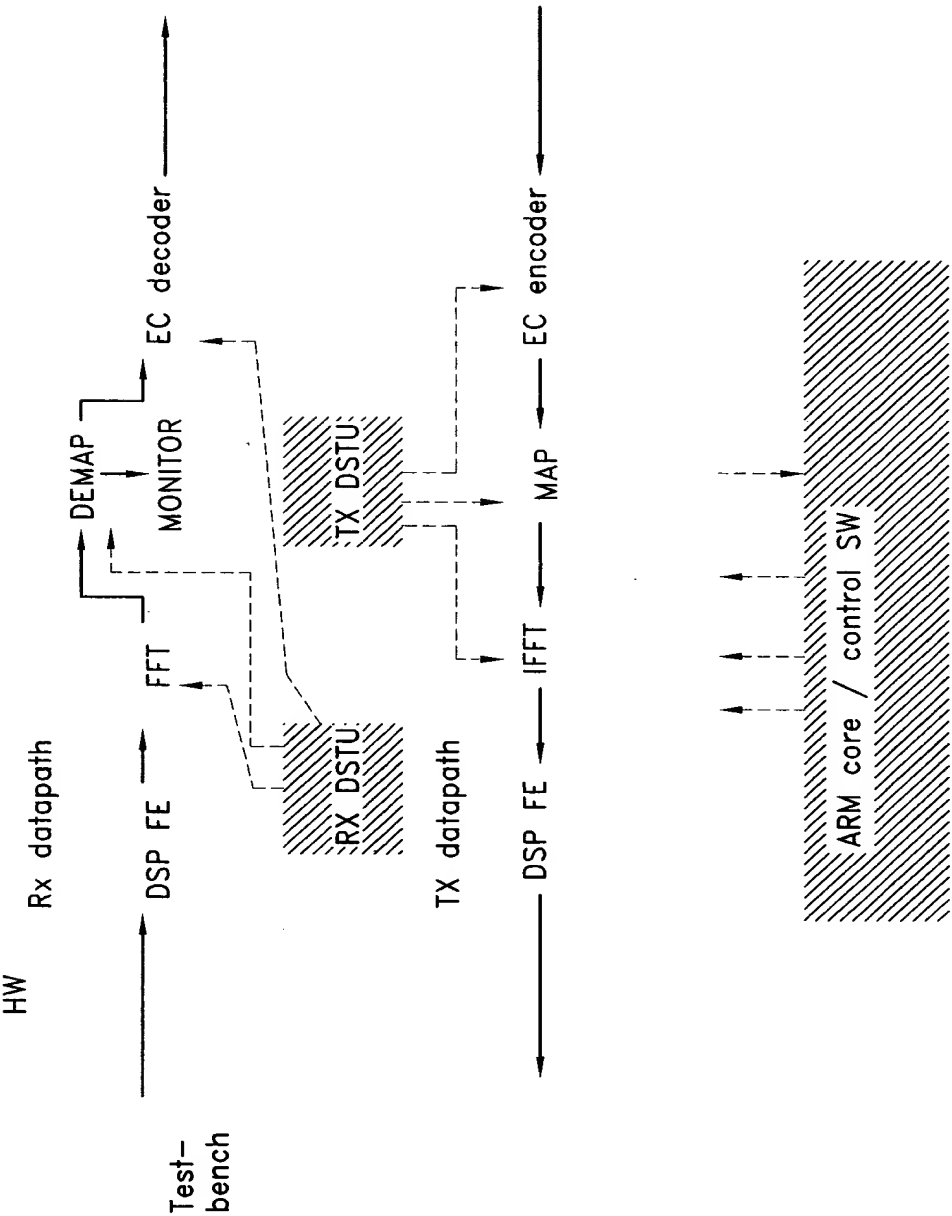


FIG. 33



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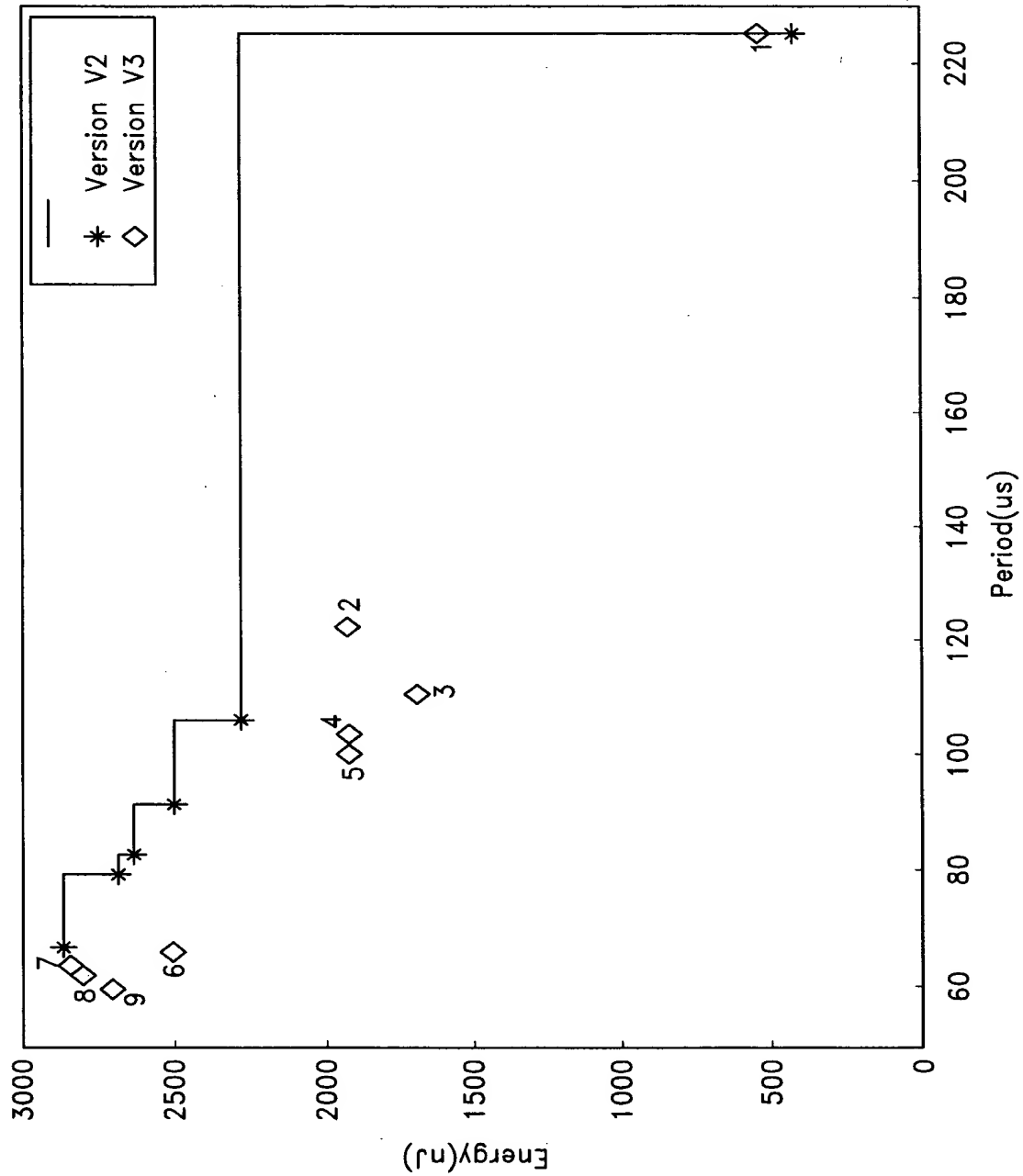


FIG. 34

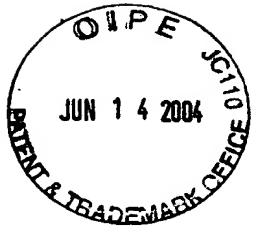


FIG. 35

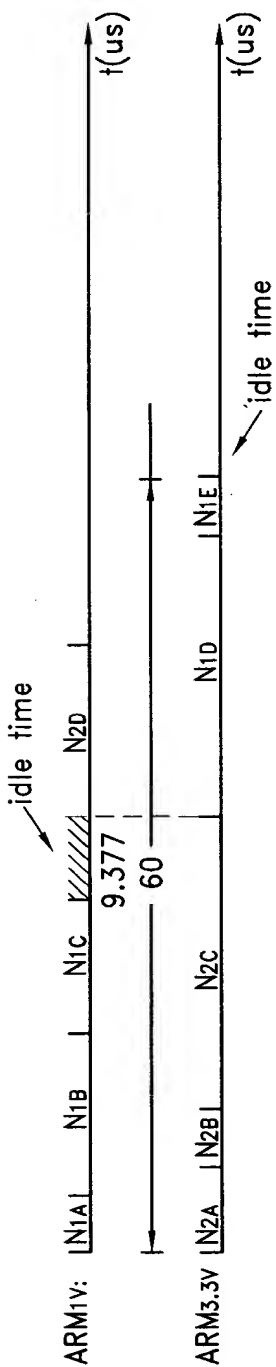
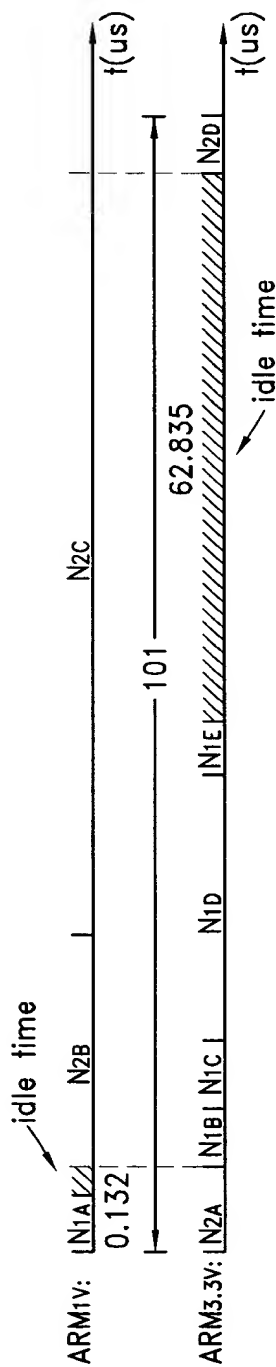
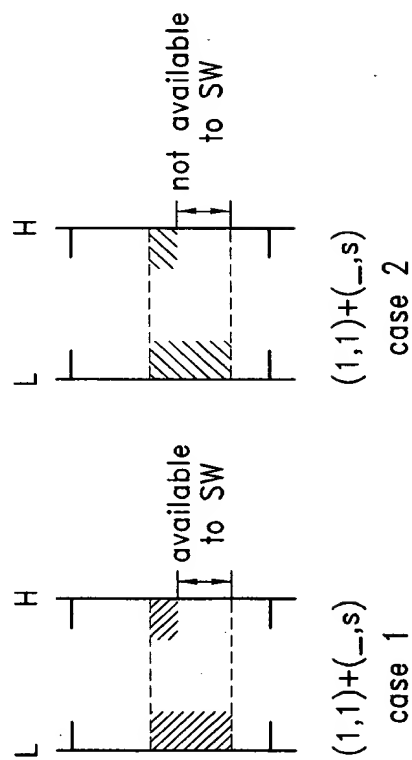


FIG. 36





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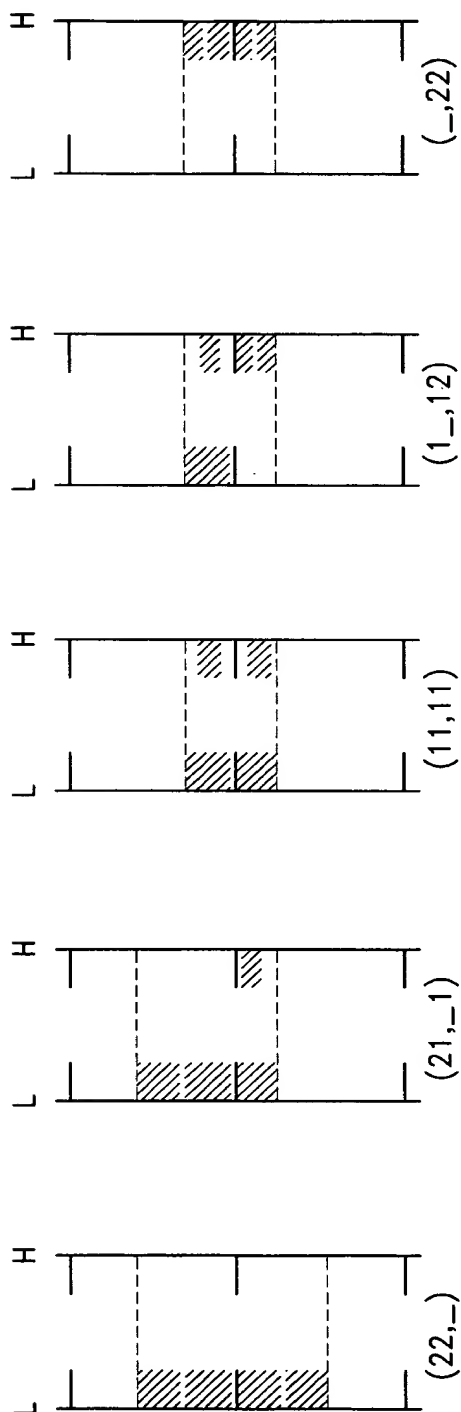


FIG. 37





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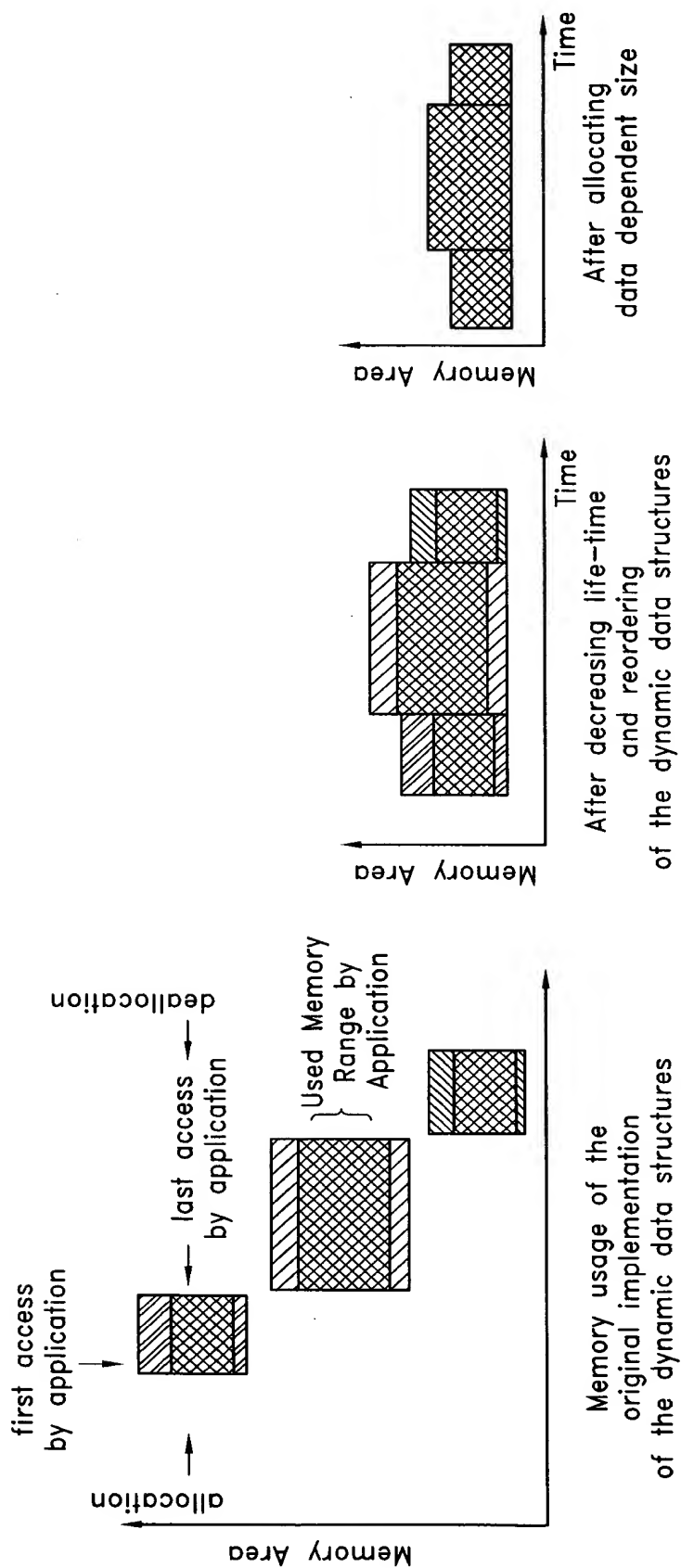


FIG. 38

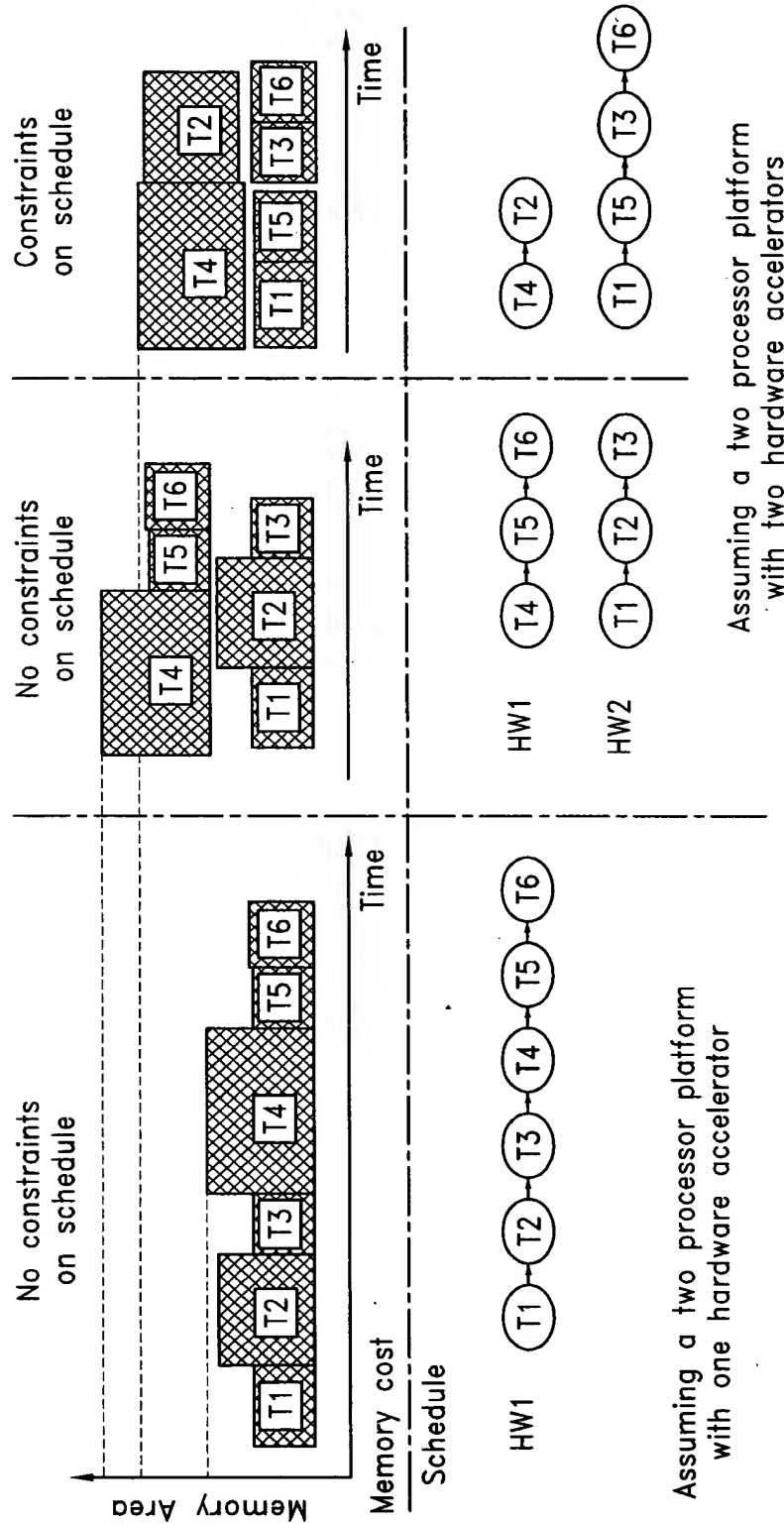


FIG. 39



	Execution Time						Energy Consumption							
	t <sub>0</sub>	t <sub>1</sub>	t <sub>2</sub>	t <sub>3</sub>	t <sub>4</sub>	t <sub>5</sub>	t <sub>6</sub>	t <sub>0</sub>	t <sub>1</sub>	t <sub>2</sub>	t <sub>3</sub>	t <sub>4</sub>	t <sub>5</sub>	t <sub>6</sub>
P1(H)	3	10	12	13	16	13	30	27	90	108	117	144	117	270
P2(L)	9	30	36	39	48	39	90	3	10	12	13	16	13	30

FIG. 40

	Thread Frame One			Thread Frame Two		
	opt.1	opt.2	opt.3	opt.1	opt.2	opt.3
Cycle Budget	20	60	100	40	60	80
Energy Cost	110	80	50	90	60	50

FIG. 41

Vdd	1 V	3 V	4 V	5 V
Frequency	10MHZ	30MHZ	40MHZ	50MHZ
Power (normalized)	1	27	64	125

FIG. 42

Task	4	5	6	7	8	9	10	11	12	14	15	16	17	18
Deadline (symbol)	128	96	128	128	768	256	128	132	16	64	16	2048	64	576
Ex. Time (ms)(10MHZ)	3	3	3	21	240	9	60	12	3	21	3	864	18	285

FIG. 43



FIG. 44

(L,H)	1,1		2,-		-,2	
	s,-	-,s	s,-	-,s	s,-	-,s
Eq. C <sub>Si</sub> (μs)	166	624	102	690	230	564
E <sub>Si</sub> +E <sub>Ti</sub> (x10 <sup>-6</sup> )	797	6247	230	6338	1364	6210

FIG. 45

(L,H)	1,1		2,-		-,2		Energy (x10 <sup>-6</sup> )
	s,-	-,s	s,-	-,s	s,-	-,s	
task4			30				6900
task7	1		65		62		100315
task8	1			138	629		1.73x10 <sup>6</sup>
task9			89				20470
task10			2	67	59		505582
task11			3	11	18		94960
task12			5		11		16154
task14			1	14	49		155798
task16	1		2	855	1190		7.04x10 <sup>6</sup>
task17			3	8	53		123686
task18	1		1	332	242		2.44x10 <sup>6</sup>
Total							1.22x10 <sup>7</sup>

FIG. 46

(L,H)	1,1		2,-		-,2	
	s,-	-,s	s,-	-,s	s,-	-,s
Eq. C <sub>Si</sub> (μs)	166	498	102	306	188	564
E <sub>Si</sub> +E <sub>Ti</sub> (x10 <sup>-6</sup> )	797	5113	230	2882	1322	6210



FIG. 47

(L,H)	1,1		2,-		-,2		Energy ( $\times 10^{-6}$ )
	s,-	-,s	s,-	-,s	s,-	-,s	
task4			30				6900
task7	123		4		1		100273
task8	429	339					$2.075 \times 10^6$
task9			89				20470
task10	10	117	1				606421
task11	12	19				1	112921
task12	14	1			1		17593
task14	32	30			1	1	186426
task16	467	1579		2			$8.45 \times 10^6$
task17	40	22	1	1			147478
task18	4	570		1	1		$2.92 \times 10^6$
Total							$1.464 \times 10^7$

FIG. 48

(L,H)	22,-,-		21,-,1		11,11		1,-,12		-,-,22	
	s,-	-,s	s,-	-,s	s,-	-,s	s,-	-,s	s,-	-,s
Eq. $C_{S,i}(\mu s)$	204	612	268	804	332	996	352	1056	376	1128
$E_{S,i} + E_{T,i}(\times 10^{-6})$	460	5764	1027	7975	1594	10226	2117	11269	2644	12420



FIG. 49

(L,H)	22,---		21,--		11,11		1--,12		--,22		Energy ( $\times 10^{-6}$ )
	S,--	--,S	S,--	--,S	S,--	--,S	S,--	--,S	S,--	--,S	
task4	15										6900
task7			4		69		1				100271
task8				2	213	168	1				$2.076 \times 10^6$
task9	45										20700
task10				2	5	57					606802
task11					6	9		1			112867
task12			2	1	5						17999
task14			1	1	14	15	1				186825
task16					234	787	1	2			$8.446 \times 10^6$
task17					20	10	1	1			147526
task18					2	284	1		1		$2.92 \times 10^6$
Total											$1.464 \times 10^7$

FIG. 50

(L,H)	222,---		221,---		121,1_1		12--,1_2		--2--,2_2	
	S,--	--,S	S,--	--,S	S,--	--,S	S,--	--,S	S,--	--,S
Eq. $C_{Si}(\mu s)$	204	816	268	1072	332	1328	364	1456	396	1584
$E_{Si} + E_{Ti}(\times 10^{-6})$	588	13440	1612	18496	2636	23552	3628	26560	4620	29568



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FIG. 51

(L,H)	222,---		221,--1		121,1_1		12_,1_2		_2_,2_2		Energy ( $\times 10^{-6}$ )
	S,--	--,S	S,--	--,S	S,--	--,S	S,--	--,S	S,--	--,S	
task4	15										8820
task7					33	7	1		1		260100
task8		1			99	154	1	1			$3.93 \times 10^6$
task9	45										26460
task10						25		1		16	$1.09 \times 10^6$
task11				1	1	8					209548
task12	1	1			2	1					42852
task14					5	14	1		1		351156
task16					41	639	1	1			$1.52 \times 10^7$
task17					8	11	1		1		288408
task18						74		1		117	$5.23 \times 10^6$
									Total		$2.665 \times 10^7$

FIG. 52

(L,H)	222,-----		2221,-----1		1221,1___1		122_,1___2		_22_,2___2	
	S,--	--,S	S,--	--,S	S,--	--,S	S,--	--,S	S,--	--,S
Eq. $C_{Sj}(\mu s)$	204	1020	268	1340	332	1660	370	1850	408	2040
$E_{Sj} + E_{Ti}(\times 10^{-6})$	716	26012	2065	35297	3710	44878	5309	51189	6908	57500



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FIG. 53

(L,H)	2222,____		2221,____		1221,1__1		122,1__2		22,2__2		Energy (x10 <sup>-6</sup> )
	S,--	--,S	S,--	--,S	S,--	--,S	S,--	--,S	S,--	--,S	
task4	15										10740
task7					33	7			1		441681
task8			1	1	57	132	1				6.18x10 <sup>6</sup>
task9	45										32220
task10					1			24		7	1.67x10 <sup>6</sup>
task11					4	4					320700
task12			1		1		1			1	68584
task14					1	3	11		1		546993
task16					1		437	72		2	2.34x10 <sup>7</sup>
task17					6	5	5				454722
task18								46		98	7.99x10 <sup>6</sup>
	Total										4.11x10 <sup>7</sup>

FIG. 54

Case Number	1	2	3	4	5
Total Energy Cost	12.2	14.64	14.64	26.65	41.1

FIG. 55

Case Number	1	2	3	4	5
Total Energy Cost	31.2	34.6	34.6	39.1	41.1





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FIG. 56

	1HW accelerator		2HW accelerators	
	Execution Time	Processor Energy	Execution Time	Processor Energy
OD	9ms	0.37mJ	9ms	0.37mJ
BIFS	24ms	0.98mJ	24ms	0.98mJ
Delivery	8.1ms	0.32mJ	16.2ms	0.64mJ
Wavelet	30ms	1mJ	30ms	2mJ
Total	30ms	2.58mJ	30ms	4mJ

FIG. 57

	1HW accelerator			2HW accelerators		
	Mem. Accesses	Mem. Size Pre	Mem. Size Post	Mem. Accesses	Mem. Size Pre	Mem. Size Post
OD	0.58k	10kB	0.58kB	0.58kB	10kB	0.58kB
BIFS	2.41k	41kB	2.41kB	2.41k	41kB	2.41kB
Delivery	35.9k	35.9kB	12.4kB	71.8k	71.8kB	17kB
Wavelet	35.9k	35.9kB	12.4kB	71.8k	71.8kB	17kB
Total	74.9k	86.9kB	14.8k	146k	193kB	19.4k

1HW accelerator		2HW accelerators	
Energy Pre	Energy Post	Energy Pre	Energy Post
0.78mJ	0.16mJ	1.54mJ	0.19mJ